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On the Kola Bean (Cola Acuminata).

By Hahnemann Epps, Associate of King's College, London.

Read Sept. 24, 1886.

This equivalent, throughout tropical and equatorial Africa, of tea, coffee, maté, cocoa, &c., has probably been used from time immemorial.

The Kola is a tree 30 to 60 feet high, belonging to the *Sterculiaceæ*, of which the *Theobroma Cacao* is a well-known member (Hooker). It yields about a cwt. of seeds annually, in two crops, the seeds or beans being enclosed in pods containing not more than 15. Specimens of these beans, both fresh and dry, are here to-night, also a small growing tree. In this paper it is hardly necessary to describe the form of the beans, but it will be as well to give the principal features of their latest analysis, so that the extraordinary properties claimed for them from time to time, during the 50 years and more that scientific attention has been directed to them, may be the better appreciated.

Analysis.—(Lascelles-Scott, 1886).

Alkaloids (principally Caffeine)	2·812
Fatty Matters	·815
Resinoid Matter	1·012
Sugar	3·914
Starch	31·120
Gum	4·876
Albuminoid Matters	8·642
Colouring Matters...	3·670
Kolatannic Acids	1·204
Mineral Matter	4·818
Moisture	9·722
Ligneous Matter and Loss...	27·395
	100·000

The earliest reference to scientific inquiry I have met with is a record in Dr. Attfield's article (which will be referred to later on) of several papers in the "Journal de Pharmacie" for 1832, p. 702, which matter, however, I have not seen. In 1865 Mr. W. F. Daniell, M.D., F.L.S., read a lengthy communication before the Pharmaceutical Society on Kola ("Pharm. Journ." [2], vi, 450), and Mr. John Attfield, Ph.D., F.C.S., followed with a paper on its analysis and food-value (*Idem*, p. 457). Mr. Thomas Christy, F.L.S., has also since 1878 given his attention to Kola, and been instrumental in making its properties widely known in this country, having dealt with the subject at considerable length ("New Commercial Plants and Drugs," Nos. 8 and 9).

In France Messrs. E. Heckel and F. Schlagdenhauffen have examined the Kola bean systematically, dealing principally with its natural history, social and political relations, chemical composition, and physiological properties. The result was a lengthy memoir read before the Union Scientifique des Pharmaciens de France, a long and interesting abstract of which appeared in the "Pharmaceutical Journal," January 26th, 1884. There have also been a few later notices on the action of the Kola bean, including one by Mr. Watson Smith, F.C.S., on its effects in excess of drinking ("Pharm. Journ.," June, 1886).

Just to give some idea of the marvellous properties claimed for Kola, it may be here recorded that the beans are said to be a powerful disinfectant, a sure preventive against dysentery and liver complaint, also enabling those eating them to support lengthened strain and labour without other sustenance. Kola bean has been recommended in cases of nervous depression, sleeplessness, melancholia, and suicidal mania, also in heart and kidney disease. But it is as a reputed remedy for dipsomania that the Kola bean is now attracting the most attention. At the Linnean Society, in 1884, one of the members gave an interesting account of the properties of the Kola bean from actual experience. He stated that the foreman of his estate in Jamaica (where the Kola was introduced about 1635) was in the habit of getting drunk every Saturday, and shortly before he had to go on duty every Monday morning, his wife used to reduce a Kola bean into a paste, which the man was made to swallow, and in thirty minutes he was quite clear in his head again. Further, he maintained that after the use of the Kola cure, a drunkard cannot return to stimu-

lants for some days without feeling nausea. There seems here an ample field for the physiological investigator, and if only a few intelligent (!) inebriates could be provided, for sobering experiments to be made upon them, the startling claim (among others) made for the Kola bean, of being a remedy for dipsomania, might be verified. This, however, is not the function of a microscopical society such as ours.

The microscopic examination of the Kola bean has not yet proceeded very far, and there must still be much to illustrate. I have on view to-night several sections of the dry bean, which show very clearly the brownish-yellow cell-walls of the tissue, packed closely with granules of starch. The Kola bean of commerce, dry, brown, roundish, about 1½ inches in size, is of a hard, tough, almost flinty character, but in its fresh state, in which state I have obtained samples, it is soft and succulent, lending itself readily to the process of cutting up into sections.

I will now proceed to mention the various points of microscopical interest that I have as yet met with, in both the fresh and dry bean.

The mass of the cotyledonary tissue is composed regularly of cells, generally sexagonal, packed full of starch granules, these becoming more and more numerous with increased distance from the surface. The cellular tissue presents no particular feature of interest. The cells themselves vary in diameter from ·0012 to ·0020 of an inch, and each cell contains (when observed in section) from 8 to 15 starch granules. The latter vary in size from ·00025 to ·0005 of an inch; are oval but rather irregular in shape, somewhat like Natal arrowroot, but smaller. There is generally a deeply marked hilum visible in the centre of each granule, which under the polariscope appears traversed by a very regular cross, and with the addition of a plate of selenite the granule is very clearly divided into pure red and green sections. It is in the tissue walls that the alkaloids caffeine and theobromine are to be found in an uncombined form, and remembering the large percentage (2·8) present, it should be comparatively easy to obtain them for microscopical examination.

The epidermis, which in the fresh bean is the principal seat of the colouring matter, is composed of a layer of oblong-shaped cells measuring about ·001 of an inch, and there are other layers of cells lying beneath, varying in size from ·001 to ·0003 of an inch.

The cells in these layers contain little if any starch. In the epidermis are found numerous stomata, which measure from ·0006 to ·001 of an inch, which are placed at irregular intervals, are oval-diamond shaped, and are generally situated in the centre of dome-like elevations. There is often considerable fungoid growth present, which has sometimes seated itself in the stomata, the walls of which have in such cases been consumed, and large irregularly shaped cavities formed in the epidermis.

It has been stated by Van Tieghem, that gum-canals are present in the pith and bark, but are absent from the cotyledons (" Bulletin Société Botanique de France," p. 11; quoted in " Pharm. Journ.," May 2nd, 1875, p. 893). This is not, however, altogether what I should have expected, as by analysis the cotyledons have been shown to contain nearly 5 per cent. of gum, besides 1 per cent. of resin. After repeated examinations of sections of the dry Kola beans, I have observed what I believe must be masses, and in some cases " canals " of gum. What I refer to may often be found near the exterior of the dry bean, in irregular masses, and in radial streaks from ·02 to ·03 of an inch long, and from ·005 to ·01 of an inch wide. There are also to be seen separate nodules, away from the masses and streaks. These masses under a $\frac{1}{4}$ inch objective have all the character of gum or resin. The correctness of my supposition I have not yet verified by dissolving out and examining the tissues afresh. I have not observed the same feature in the fresh bean, and the masses referred to may consist partly of sugar, of which the analysis shows nearly 4 per cent.

Repeated microscopical examination has not afforded any other results. What must remain the most noteworthy features of the Kola bean are, the immense percentage (31·120) of starch present, also of alkaloids (2·812), and the all but complete absence (·815) of fatty matters. It is this last feature that most distinguishes Kola from the other members of the *Sterculiaceæ*.

Notes on Zoothamnium Arbuscula.

By James Spencer, F.R.M.S.

(Read October 22, 1886.)

Plate I.

All the members of the Club are no doubt more or less familiar with the appearance of this organism, which bears a general resemblance to a minute apple tree, with trunk, boughs, branches, twigs, leaves, and fruit. Mr. Saville Kent, in his "Manual of the Infusoria," says :—"Examined separately, each colony-stock may be compared to a minute crystalline standard fruit tree, of which the ordinary campanulate zooids may be likened to the leaves, and the spheroidal or reproductive units to the fruit." The muscular fibres all contract at the same time, and from time to time change the appearance of the organism, from that of a tree into that of a fluffy ball. I do not propose, however, to attempt to give any complete description of the species, but merely to note some observations of my own.

The specimen which I observed was obtained by me at Walton-on-Thames, on Saturday, the 11th of September, 1886, and was attached to a rootlet of willow, on which there were besides some sponges and other living organisms. It was placed in an observing trough, holding half-a-pint of water brought from Walton. Its natural size is shown in Plate 1, Fig. 1. In Figures 2 and 3 are sketches of it, × 10 diam., fully expanded and contracted, and Fig. 4 is a drawing of a branch × 50 diam. I placed a microscope in front of the tank, and gave the object an occasional look. I noticed nothing particular till the following Tuesday morning, when I saw upon the colony one fully-grown spheroidal zooid, and eight others of various sizes, which afterwards became as large as the first one. They were distributed pretty evenly about the colony, and were in shape slightly prolate spheroids. I continued my observations of these bodies from time to time as opportunities offered themselves, and on the following Thursday morning found that only eight remained, and that changes were taking place in some of them. One had become shaped somewhat like a peg top

without the peg, and was furnished round the widest part with an undulating ribbon or membrane of sarcode broken at the edges, but not quite developed into cilia, parts of which moved slowly like little tongues of flame, some waving in one direction, some in another. In the course of five minutes this membrane became completely divided into cilia, which commenced the characteristic movements of the cilia of the vorticella, and in a few seconds acquired rapid movement, when the creature became disconnected from the parent stem and swam out of the field of view. When I first observed it on the Thursday morning it had already acquired the shape shown in Fig. 7, and when it was detached it was shaped as in Fig. 9. I continued watching the colony, and saw that near the point of junction of another spheroid with the stem a slight movement of a mere thread of sarcode projecting from the periphery. This became gradually broader, forming a thin undulating ribbon, attached by its edge to the ball, and insensibly rising until it occupied the position shown in Fig. 6; then the ball very gradually altered in shape until it resembled two conoidal bodies united at their bases, as shown in side and front view at this stage in Figs. 7 and 8. In a few seconds it assumed the shape indicated in Fig. 9, with swiftly vibrating cilia, and detached itself and swam away. I saw another spheroid pass through all these changes on the Thursday evening, and saw the last of the nine do so the next day.

While the alterations in the reproductive zooids were progressing, the ordinary campanulate zooids gradually disappeared, and when the last reproductive zooid swam away there were but a few of the ordinary zooids left at the ends of the twigs, but the muscular system was contracting as vigorously as ever. I saw the objects I have described in all positions, and the nature of the changes was very distinctly visible. From the time I began to observe each of the zooids, in which I saw the whole of the changes from a spheroid attached to the colony to a freely swimming bell, I did not take my eye from the microscope, the time occupied in each case being from 30 to 35 minutes.

West, Newman & Co. lith.

On a Fossil Marine Diatomaceous Deposit from Oamaru, Otago, New Zealand.

By E. Grove and G. Sturt, F.F.R.M.S.

PART II.

Plates II., III.

(*Taken as Read, November 26th*, 1886.)

Triceratium intermedium, n. sp., Gr. & St.—Valve small, with four rounded angles, and distinct nodules. Sides slightly convex, Centre clear. Rest of surface sparsely dotted except at the margin, which is edged with two rows of closely-set granules. Length of side ·0022″. Rare. (Pl. II, Fig. 1.)

T. lineatum, Grev. ("T. M. S.," Vol. xi, p. 75, Pl. 5, Fig. 24).—Agrees with Greville's figure, except in having four instead of three clear linear spaces within each angle. Length of side ·0075″. Rare.

A form of this species occurs with two processes only, which we figure as an additional proof of the connection between the genera *Triceratium* and *Biddulphia*. (Pl. II, Fig. 2.)

T. obesum, Grev. ("T. M. S.," Vol. xii, p. 90, Pl. 13, Fig. 11.) —Scarce.

T. crenulatum, n. sp., Gr. & St.—A very distinct species, frequent in this deposit. Valve with four indentations or "scallops" in each side. Centre and angles elevated, the latter produced into distinct nodules. Umbilicus clear, surrounded by a ring of small granules, from which lines of larger granules, about 8 in ·001″, extend to the margin. This species varies in outline some specimens having concave, and others gibbous margins, with very shallow indentations. A curved line may be seen at the base of the raised angles, particularly in the gibbous forms. Length of side ·005″. (Pl. II, Fig. 3, typical. Fig. 4, formâ gibbosa.)

T. neglectum, Grev. ("T. M. S.," Vol. xiii, p. 7, Pl. 2, F. 20). —Rare, but corresponding with Greville's form.

T. Morlandii, n. sp., Gr. & St.—Valve with slightly concave sides and large prominent ovate nodules, covered with delicate granules. In the centre is a blank space, surrounded by two or

three circles of granules, increasing in size outwards ; from this to the margin run radiating costæ, enclosing large oblong cells, extending at the sides to the margin, but shorter opposite the angles. At the foot of each nodule is a blank space, covered with large granules, resembling those at the centre. Between the radiating costæ are double lines of granules. A very beautiful form, which we have much pleasure in naming after the introducer of this deposit. Distance between angles of specimen figured, ·0044″. A smaller form also occurs, ·003″ length of sides. (Pl. II, Fig, 5.)

Entogonia Davyana, Grev. (*Triceratium Davyanum*, Grev., "Q. J. M. S.," Vol. ii, n.s., p. 232, Pl. 10, Fig. 4).—A variety of this form occurs, in which the transverse lines in the central compartment, and the clear spaces at the base of each process shown in Greville's figure are wanting.

Eunotogramma Weissii, Ehr., var. *producta*, n. var. Gr. & St. (*E. Weissii*, Grun., in "Franz. Jos. Land," p. 7, Pl. B., Fig. 21-22), —Valve with very prominent, sharply-defined, central projection ; considerably produced towards the ends, and terminating with elongated angles. The surface of the valve is covered with scattered granules. Length up to ·0088″. Breadth at centre ·003″. (Pl. II, Fig. 6. Frustule, Fig. 7.) We have classed this as *Eunotogramma*, following Grunow, but it is totally distinct from *E. variabile*, Grun., which may be taken as the type of the genus. *E. Weissii* has great affinity to the *Biddulphiæ*.

Aulacodiscus Crux, Ehr. ("Grun. Franz. Jos. Land," p. 17, vars. "Schm. Atl.," Pl. 33, Fig. 1-3).—Small forms are not unfrequent up to ·0052″ in diameter. The smaller forms suggest the var. *tenera*, Witt. ("Simbirsk," p. 19, Pl. 6, Fig. 10).

A. Comberii, Arnott ("Pritch.," p. 844). Scarce but typical.

A. decorus, Grev. ("T. M. S.," Vol. xii, p. 82, Pl. 10, Fig. 2). —Rare. Processes six in number. Diameter, ·012″.

A. Stoschii, Janisch ("Schm. Atl.," Pl. 34, Fig. 11 ; Walker and Chase, "New and Rare Diatoms," p. 3, Pl. 1, Fig. 2).—Scarce. Corresponding to Walker and Chase's form. Processes seven in number. Diameter up to ·02″. This form is closely allied to *A. inflatus*, Grev., or the better known *A. formosus*.

A. cellulosus, n. sp., Gr. & St.—Valve covered by radiating, distinctly punctate, irregular hexagonal cellules, with a central rosette of small oblong cellules. Furrows distinct, formed by two parallel rows of cellules running from the central rosette to the

processes, which are small, submarginal, and 4-9 in number. Extreme margin striated. Diameter up to ·0066″; cellules seven to eight in ·001″. Not very rare.—Pl. II, Figs. 8 and 9.

A. Beeveriæ, Johnson ("Prich.," p. 844, Pl. 6, Fig. 5).—Forms with three or four processes are not unfrequent. Diameter ·005″. A form with only two processes also occurs.

A. angulatus, Grev. ("T. M. S.," Vol. xi, p. 71, Pl. 5, Fig. 15; "Schm. Atl.," Pl. 34, Fig. 8).—Not unfrequent. Processes 8 or 9; the size varies considerably from ·005″ to ·011″ in diameter.

A. margaritaceus, Ralfs. ("Prich.," p. 844; "Schm. Atl.," Pl. 37).—A form with four processes, ·007″ in diameter, occurs; a very large variety (with processes up to 11), attaining a diameter of ·028″, is not very rare in the heaviest density.

A. amœnus, Grev., var. *sparso-radiata*, n. var. Gr. & St. (Grev. in "T. M. S.," Vol. xii, p. 10, Pl. 1, Fig. 3).—Differs from the type by its larger size, and the greater distance between the radiating lines of granules. Diameter up to ·009″. Lines of granules six in ·001″. Smaller forms more closely resemble the type, while the largest ones suggest *A. oreganus*. The processes vary up to 10 in number; and the disc is not convex. Not unfrequent.

A. Sollittianus, Norm. var. *nova Zealandica*, n. var. Gr. & St. (Norm. in "T. M. S.," Vol. ix, p. 7, Pl. 2, Fig. 5).—In general aspect resembles the type; but is smaller, with only three processes, and a well-defined, striated margin. The umbilicus is sometimes wanting. The cellules are about 11 in ·001″, and the diameter varies up to ·0075″. Not rare. (Pl. III, Fig. 10.)

A. notatus, n. sp., Gr. & St.—Valve small with indistinct umbilical space, and four large opposite, almost circular, hyaline, submarginal spaces about ·001″ diam.; from the centre of each of which projects a very short urn-shaped process. The valve is slightly inflated towards the processes, leaving between the hyaline spaces a slight depression; the surface is covered with fine radiating granules, which at the centre are irregularly arranged. The furrows are narrow, but quite distinct; the margin is well defined by a clear zone. Diameter, ·004″. Rare. A very delicate form, distinguished from other species in the genus by the large hyaline spaces. (Pl. III, Fig. 11.)

Glyphodiscus stellatus, Grev. ("T. M. S." Vol. x, p. 91, Pl. 9, Fig. 5.)—Scarce. Similar to that occurring in the Californian deposits; up to ·0035″ in diameter.

G. scintillans, A. Schm. (" Atl.," Pl. 80, Fig. 7).—A variety rarely occurs; one observed with 14 processes.

Auliscus racemosus, Ralfs. (Grev. in " T. M. S." Vol. xi, p. 46, Pl. 2, Fig. 9; Schm., " Atl.," Pl. 30, Fig. 12, 13). Small and scarce.

A. pruinosus, Bail. (Grev., *loc. cit.*, p. 48, Pl. 3, Fig. 13).—In addition to the radiating lines, the surface is slightly punctate, corresponding with the figures of *A. punctatus*, Bail., in " Atl.," Pl. 31, Fig. 8, 9. Scarce.

A. notatus, Grev. ("T. M. S.," Vol. xiii, p. 5, Pl. 1, Fig. 2).—A form occurs rarely, which we consider a variety of Greville's species. The valve is larger, and the surface is covered with close-set, fine granular dots, in addition to the numerous large, well-defined puncta; there is no umbilical space. Diameter, ·004″. It is very probable that this form is merely a variety of *A. punctatus*, Grev. (nec. Bail.), " T. M. S.," Vol. xi, p. 49, Pl. 3, Fig. 15, 16.

A. punctatus, Bail. var. (A. Schm. "Atl.," Pl. 67, Fig. 7).—Differs from the typical form in the presence of a crescent-shaped clear space enclosing the inner half of each process. This space is more clearly defined in our form than in the figure in the Atlas. Diameter ·004″.

A. Barbadensis, Grev. (" T. M. S.," Vol. xiii, p. 5, Pl. 1, Fig. 1).—This is more oval than Greville's form, but in other respects closely resembles it; the radiating characteristic lines being especially distinct.

A. fenestratus, n. sp., Gr. & St.—Valve small, oval; processes two, small, situated at a little distance from the margin; umbilicus subdistinct. On the inside of each process, and partly encircling it, is a crescent-shaped clear space; then, for a little distance inwards, the valve is flat, but gradually becomes slightly depressed as it approaches the centre; the point where the depression commences being marked on each side by a narrow clear space, extending nearly across the valve. Surface covered with markings resembling those of *A. pruinosus*. Not scarce. Diameter generally up to ·003″. One specimen observed with diameter of ·0045″., (Pl. III, Fig. 12.)

A. cœlatus, Bail. (Grev. " T. M. S.," Vol. xi, p. 44, Pl. 2, Fig. 4-7).—A variety of this is rare.

A. Oamaruensis, n. sp., Gr. & St.—Valve nearly circular, large; processes two, very prominent; umbilicus similar to that in *A.*

Hardmannianus, Grev., ("T. M. S.," Vol. xiv, p. 6, Pl. 2, Fig. 17). The markings are formed of large rough Costæ, arranged in four sets, two of which converge to the processes, whilst the others radiate along the lateral depressions continuously to the margin. Longest diameter of largest observed ·009″ (Pl. III, Fig. 13.)

Euodieæ.

Euodia Janischii, Grun. ("V. H. Synop.," Pl. 127, Fig. 1-4). —Scarce.

E. striata, n. sp., Gr. & St.—Valve small, similar in shape to *Eunotia faba*, Ehr., with small terminal nodules. Dorsal margin moderately curved, ventral nearly straight. Striæ radial, about nine in ·001″, composed of very short transverse lines about 45 in ·001″. Length to ·003″. Breadth ·00056″. (Pl. III, Fig. 14).

Hemiaulidæ.

H. includeus (Ehr.), Grun. ("Franz. Jos. Land," p. 12, Pl. B., Fig. 36, 38). Not unfrequent. *H. capitatus*, Grev. ("T. M. S.," Vol. xiii, p. 54, Pl. 6, Fig. 24). seems a similar form, and perhaps identical.

H. ornithocephalus, Grev. ("T. M. S.," Vol. xiii, p. 32, Pl. 3, Fig. 16).—A form which we identify with this species is not very rare; it is, however, slenderer than Greville's figure; and the horns more elongated, but in other respects similar.

H. tenuiformis, Grev. ("T. M. S.," Vol. xiii, p. 29, Pl. 3, Fig. 10).—Frequent.

H. lyriformis, Grev. (*loc. cit.*, p. 30, Pl. 3, Fig. 11).—Not frequent.

H. Barbadensis, Grun. ("Franz. Jos. Land," p. 11).—Frequent.

H. polymorphus, Grun. (*loc. cit.*, p. 14).—Forms of this, varying considerably in appearance, are numerous.

While this part of our paper was going through the press we were shown a copy of a letter received by Professor Rupert Jones from Captain F. W. Hutton, Professor at Canterbury College, Christchurch, New Zealand, dated in January of this year, enclosing a sample of this deposit for examination, and giving particulars of its geological age and position. It appears from this that Captain Hutton is the original discoverer of this deposit; and we accordingly hasten to acknowledge our indebtedness to him and tender him our thanks.

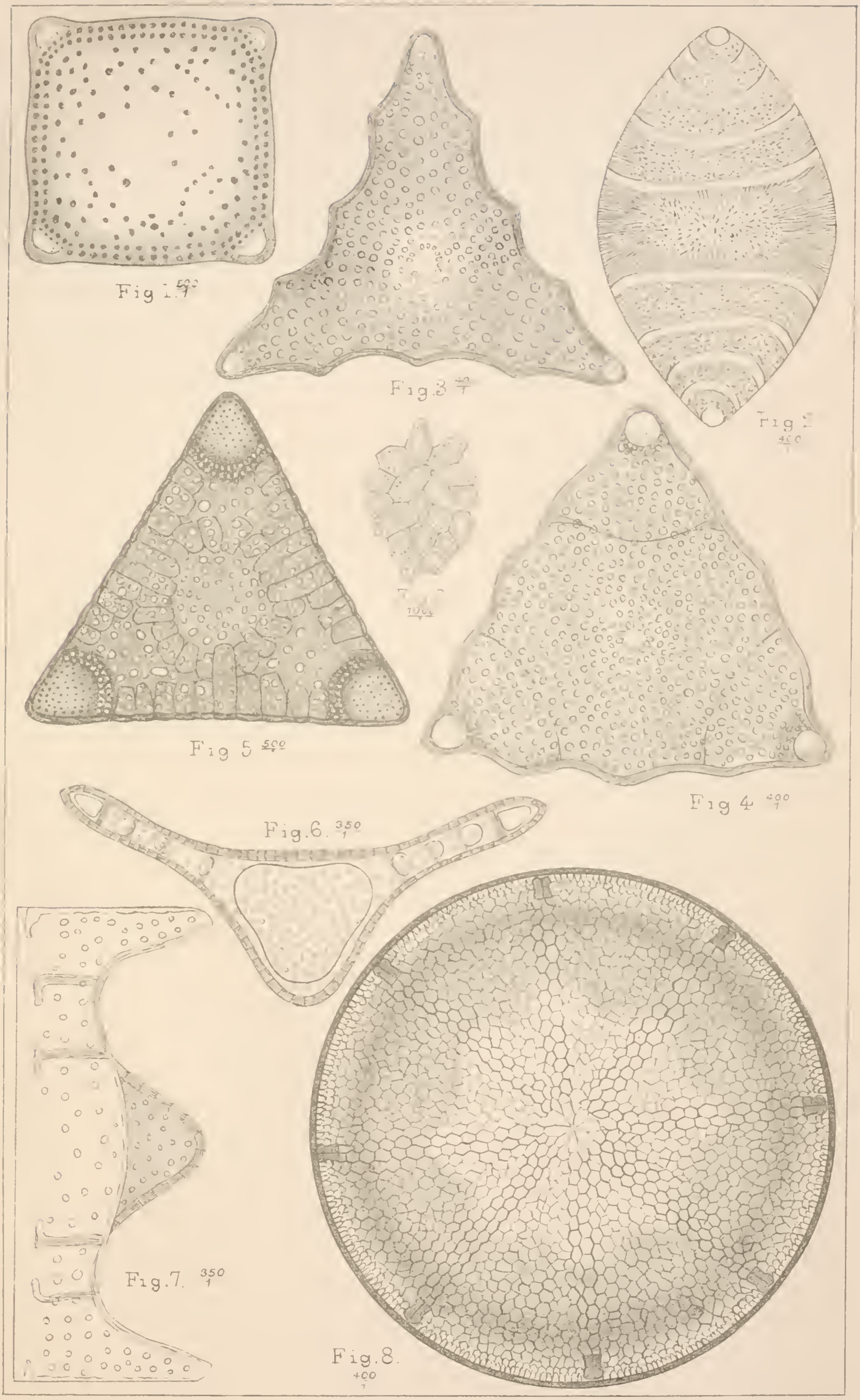
DESCRIPTION OF PLATES.

PLATE II.

FIG. 1. *Triceratium intermedium*, Gr. and St., n. sp., $\frac{500}{1}$.
,, 2. ,, *lineatum*, Grev., var., $\frac{400}{1}$.
,, 3. ,, *crenulatum*, Gr. and St., n. sp., $\frac{400}{1}$.
,, 4. ,, ,, forma gibbosa, $\frac{400}{1}$.
,, 5. ,, *Morlandii*, Gr. and St., n. sp., $\frac{500}{1}$.
,, 6. *Eunotogramma Weissii*, Ehr., var. *producta*, Gr. and St., valve, $\frac{350}{1}$.
,, 7. ,, ,, ,, frustule, $\frac{350}{1}$.
,, 8. *Aulacodiscus cellulosus*, Gr. and St., n. sp., $\frac{400}{1}$.
,, 9. ,, ,, Portion highly magnified, $\frac{1000}{1}$.

PLATE III.

,, 10. *Aulacodiscus Sollittianus* var. *Nova Zealandica*, Gr. and St., $\frac{400}{1}$.
,, 11. ,, *notatus*, n. sp., Gr. and St., $\frac{650}{1}$.
,, 12. *Auliscus fenestratus*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 13. ,, *Oamaruensis*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 14. *Euodia striata*, n. sp., Gr. and St., $\frac{500}{1}$.



West, Newman & Co. lith

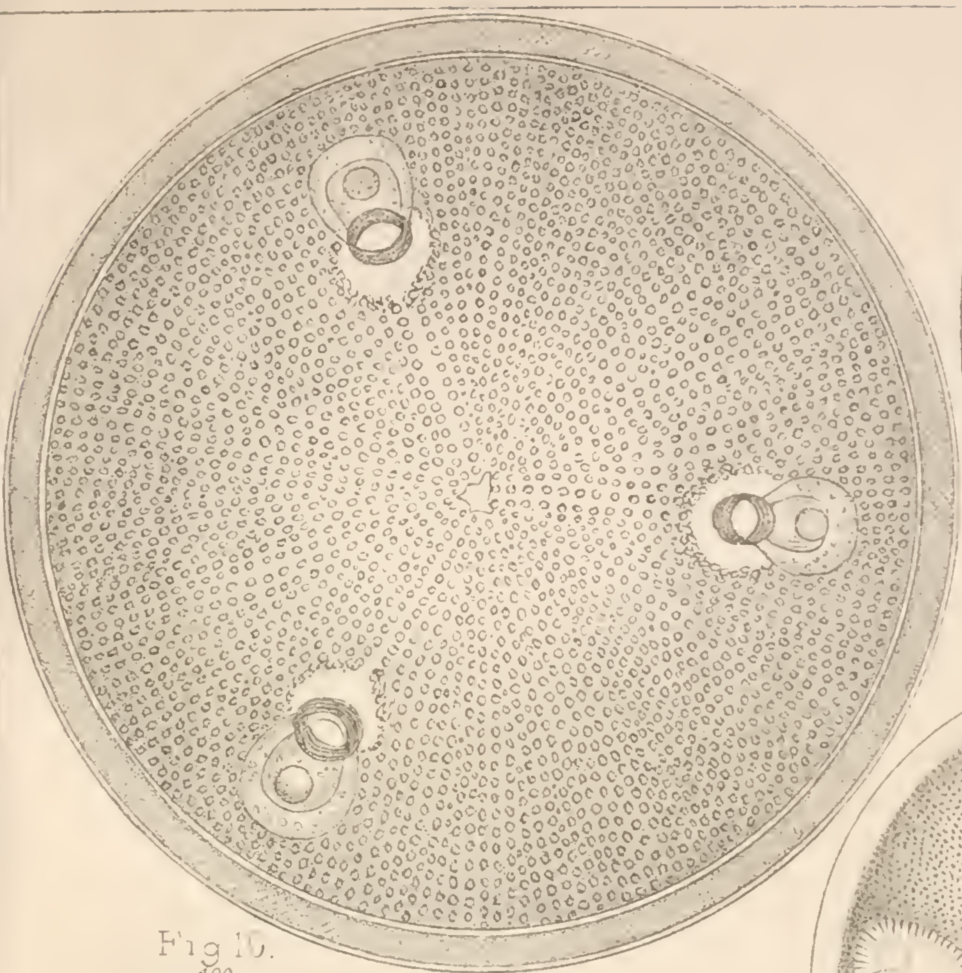


Fig. 10.
$\frac{400}{1}$

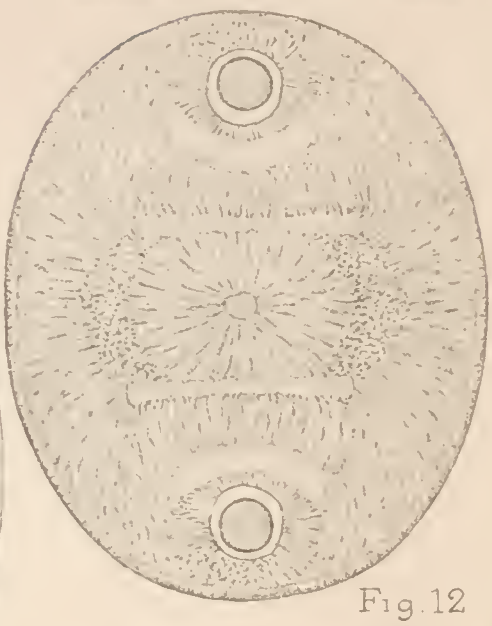


Fig. 12
$\frac{400}{1}$

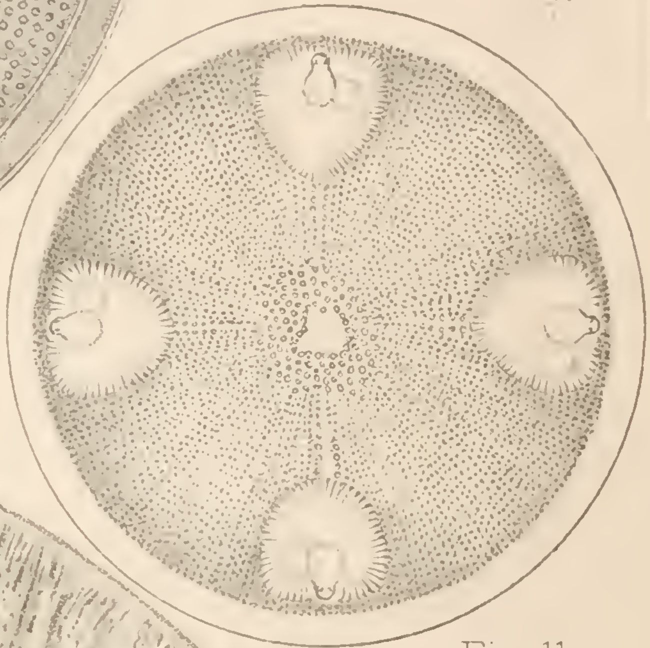


Fig. 11.
$\frac{650}{1}$

Fig. 13.
$\frac{400}{1}$

Fig. 14.
$\frac{500}{1}$

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On a Method of Finding the General Character of the Components of a Cemented Combination Lens.

By E. M. Nelson.

(Read November 26th, 1886.)

Some microscopists take no special interest in their lenses, beyond occasionally wiping the front, and brushing the dust, when it gets too thick, with a camel's-hair pencil from the back.

Others unscrew the combinations to clean them, and like to know whether they are composed of two, three, or four sets of lenses.

Some, again, know all about the components of each combination, and some wish they did. It is to this last class of inquirers that this paper is directed.

Let me first say that there is only one way of finding out the *exact* composition of a lens, and that is by taking down every combination, uncementing every lens, measuring the exact curvature, and the refractive and dispersive power of the glass of which it is made.

It will be admitted, however, that it is very useful to know whether a combination consists of two, or three lenses, and if those are biconvex, biconcave, plano-convex, meniscus, &c. To find such information without uncementing a combination is the scope of this paper.

The method I employ, is simply the consideration of the reflected images from the surfaces of the glass. Take the plain mirror of your microscope in your hand, and examine the reflection of a window, notice that it is an erect image, and that when you move the mirror in a certain way the image appears to come towards you.

Now look at the concave side, the image is inverted, and when the mirror is moved in the same direction as before the image goes away from you.

A convex mirror behaves as a plain mirror, there being only this difference, that the greater the convexity the smaller is the

image; which difference is also true of a concave mirror, viz., the greater the concavity the smaller the image.

If you now examine a single biconvex lens, you will see a large erect image from the surface next the window, and a small inverted image from the surface on the other side. It acts precisely as if it were a convex and a concave mirror. In a single biconcave lens you have a large inverted, and a small erect image. In a plano-convex, with the convex side towards the window, you will find a small erect image from the convex side, and a large inverted image from the plane side. With the plane side towards the window, you will have a large erect image from the plane side, and a small inverted one from the other side.

With the concave side of a plano-concave towards the window, the concave side will give an inverted image, and the plane side an erect image; but with the plane side to the window, you will get two erect images. Converging and diverging menisci have for their convex sides two erect images, and for their concave sides two inverted. I find, however, that in a converging meniscus, if the concave surface is of very large radius, the reflection from it, when viewed from the convex side, will be inverted instead of erect; in other words, it will take the form of a plano-convex. I imagine that in a diverging meniscus, which closely approximates the form of a plano-concave, the same result would be found, viz., that the image from the flat side, seen through the more concave side, would be erect instead of inverted, as one would expect; but of this I have no practical experience, as I have not got a lens of that form to experiment on.

Now, if we take a cemented doublet, consisting of a biconvex and a plano-concave, we shall very easily see the two bright reflections from the two exterior surfaces, viz., the plane and the convex. The image from the cemented surfaces, however, will not be so readily apparent. With a little attention it will be discovered as a faint image, with most probably a bluish tinge, though occasionally it may have a reddish tinge. When once seen it will be easily recognized again. A triple combination will have two faint images, as well as two bright ones. I find the following the best method of procedure:—

First, find out by the number of faint reflections if the lens

is a doublet or a triplet. Next find out the nature of the exterior surfaces, and write them down, *e.g.*, plano-convex doublet. This means that the combination is composed of two lenses, and that one of the exterior surfaces is convex and the other plane. Now write down the reflections as they come, beginning at the side next the window, underlining the reflection from the first surface, and putting the reflection from the cemented surface in parenthesis. In writing these down I use the following abbreviations:—*e* for erect, *i* for inverted, *s* for small, *l* for large, and *L* for very large. It is a good plan to draw the lens by representing, first the exterior surfaces only, and then filling in the cemented surfaces, according to the reflections you obtain. It is absolutely necessary that the character of the reflections from both sides of the combination should be ascertained, as it is impossible to discover the construction of the combination from one set of reflections.

When the images are large, it is as well to look at the reflection of the bar across a window; the knob of the hasp showing if the image is erect or inverted.

The images from small lenses require to be examined by a magnifying glass.

One word of caution, and that is, until one is practised in picking up these faint images the very large faint ones are apt to be overlooked. Until one is familiar with the manner of holding a lens only a faint blue tinge will be seen over the glass, but after a little practice a distinct image of the window bar will be obtained.

The following are a few examples:—

A plano-convex doublet:—

Convex side, *se* (*si*) *li*.

Plane side, *le* (*se*) *si*.

It therefore consists of a biconvex and a plano-concave.

The next two form an interesting pair.

A converging meniscus doublet:—

Convex side, *se* (*si*) *li*.

Concave side, *li* (*se*) *si*.

This, therefore, consists of a biconvex, and a biconcave.

Another lens of the same exterior form:—

Convex side, *se* (*se*) *li*.

Concave side, *li* (*si*) *si*.

This consists of a converging and diverging meniscus. The difference between these two last combinations is at once shown by the different characters of the reflections from their cemented surfaces. The intelligent observer will note that the concave exterior surface when seen through the convex surface has its sign changed from *e* to *i;* of this I spoke above.

An unequal biconcave doublet :—

Most concave side, *li* (*se*) *si*.

Least concave side, *Li* (*si*) *se*.

It consists therefore of a biconcave and a converging meniscus. The *si* in the most concave side is not what one would have expected. The interior curve of the meniscus must have a short radius, so that it overpowers the exterior concave surface of the biconcave. The least concave side is very flat, as shown by *L*.

A biconvex triple, equiconvex :—

e (*i*) (*e*) *i* both sides alike.

It consists of a biconvex, binconcave, biconvex. A plano-convex triple consisting of a biconvex, a biconcave, and a plano-convex, will have the same form, only the plane side will be *Le* instead of *se* and *li* instead of *si*.

An unequal biconvex triple as in a properly constructed opera glass objective :—

Most convex side, *le* (*si*) (*Li*) *li*.

Least convex side, *le* (*Le*) (*se*) *si*.

The lenses are therefore biconvex, diverging, and converging menisci.

A biconcave triple as in a properly constructed opera glass eye-piece :—

From side of thickest lens, *li* (*se*) (*le*) *se*.

From side of thinnest lens, *li* (*Le*) (*li*) *se*.

Its form is biconcave, converging meniscus, and diverging meniscus.

If the middle were a piece of plain glass, which is sometimes fraudulently put, its form would be :—

i (*e*) (*e*) *e*,

which would read the same from both sides. But if it had a thin converging meniscus in the middle, it would read :—

li (*le*) (*le*) *se* from one side.

li (*Le*) (*Le*) *se* from the other.

You will notice that the diverging meniscus turns the (i) into an (e), following a plano-concave as I hinted above, only making the s into an L.

These examples will be sufficient to make anyone acquainted with the method I employ.

I have for long thought it was possible to find out the character of a combination by means of the reflections, but having only received negative replies to my repeated inquiries from those who ought to know, I have been deterred from investigating the matter for myself until this summer.

PROCEEDINGS.

August 13th, 1886.—Conversational Meeting.

There were no objects exhibited, and the meeting separated at an early hour.

Attendance—Members, 16; Visitors, 1.

August 27th, 1886.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., in the Chair.

In the absence of the President, Vice-Presidents, and Secretary, Mr. H. F. Hailes called upon the members present, in accordance with Rule 4, to appoint a chairman for the evening. Mr. J. G. Waller was accordingly elected.

Mr. Hailes read the minutes of the preceding meeting, which were duly confirmed.

Mr. W. S. Daddo was balloted for and elected a member of the Club.

The following donations to the Club were announced:—

An old work on Natural Philosophy ...	From Mr. Crisp.
A copy of "Quekett" on the Microscope, in German	
"Papers on the Microscope," in German	
"The American Naturalist"	In exchange.
"The Botanical Gazette"...	" "
"Proceedings of the Belgian Microscopical Society"	" "
"Proceedings of the New York Microscopical Society"	" "
"The American Monthly Microscopical Journal"	" "
"Annual Report of the Brighton and Sussex Natural History Society"	" "
"Journal of the Royal Microscopical Society"...	" "
"British Desmids," No. 2	Purchased.

The thanks of the Club were voted to the donors.

The Chairman having remarked that they had no paper to bring before the meeting, expressed a hope that some member present would be able to communicate something of interest.

Mr. Buffham thought it would be a good thing if the Society would make a rule that no meetings should be held in the summer, as there were so many members absent during July and August. He hoped, however, that someone present who had been for a holiday would be able to describe something which he might have come across.

No response being made to the Chairman's appeal, notices of excursions, &c., for the ensuing month were given out, and the meeting terminated in the usual Conversazione, and the following objects were exhibited:—

Actinophrys Eichhornii, Ehr. ... ... = *Actinospherium Eichhornii* (Huxley)...	Mr. F. W. Andrew.
Volcanic dust ejected during the late eruption of Tarawera, New Zealand	Mr. H. G. Glasspoole.
Pre-cambrian volcanic rocks, lavas, and tufa from the Wrekin, and tertiary lavas, &c., from Hungary, compared	Mr. G. Smith.

Attendance—Members, 31; Visitor, 1.

September 10th, 1886.—Conversational Meeting.

The following objects were exhibited:—

Cordylophora lacustris	Mr. F. W. Andrew.
Gall fly of oak, *Cynips*	Mr. F. Enock.
Living poduræ	Mr. G. Hind.
Diatoms, *Triceratium sculptum*	Mr. H. Morland.
Spirogyra nitida	Mr. J. Spencer.

Attendance—Members, 25; Visitor, 1.

September 24th, 1886.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

Mr. H. F. Hailes (in the absence of the Secretary) read the minutes of the preceding meeting, which were duly confirmed.

The following additions to the Library were announced:—

"The American Naturalist"	In exchange.
"The Scientific Inquirer"...	„ „
"Proceedings and Report of the Bristol Natural History Society"	„ „
"The Botanical Gazette"...	„ „

"Proceedings of the New York Microscopical Society"	In exchange.
"Grevillea"	Purchased.
"British Desmids," Part 3	"
"Annals of Natural History"	"

Mr. H. Epps read a paper on "Kola"—a new commercial plant, said to possess some very remarkable properties. The subject was illustrated by the exhibition of a growing plant, also by specimens of the nuts, together with samples of the powder prepared therefrom, and by sections of the nut shown under the microscope. Samples of the powder, &c., were offered for distribution amongst those members who were interested in the subject.

The President said they were very much obliged to Mr. Epps for his interesting communication. He perfectly well remembered the evening when the subject was brought before the Linnean Society, and was much struck by the evidence which was given—as it seemed quite by accidental circumstance—in confirmation of the statements made by the reader of the paper. Mr. Christy brought the matter before the Society as something new, and a gentleman who was present, and said he was a West India planter, got up and stated that he was quite well acquainted with the plant and the effects of its preparations, and then told how he had a foreman who was an excellent servant, but whose one drawback was his liking for spirituous liquors. This man used to indulge freely in drink as soon as work was over on Saturday, and remained under its influence until the middle of Sunday, when his wife gave him a spoonful of the prepared kola, which had the effect of rapidly counteracting the effects of the alcohol, and enabled him to appear at the house and take his orders intelligently. There appeared to be several other persons in the room who were acquainted with the power of the kola nut as an antidote to alcoholic poisoning. The repugnance with which alcohol was regarded by persons to whom this drug had been administered was possibly a property upon the advantages of which everyone might not be entirely agreed, but it was probable that the nut possessed a stimulating property which might have a sustaining action, and this, together with its peculiar antagonism to alcohol, made it an exceedingly interesting production, and one well worthy of the attention of a Society such as theirs.

The thanks of the meeting were voted to Mr. Epps for his communication.

Announcements of meetings, &c., for the ensuing month were then made and the proceedings terminated with the usual Conversazione, the following objects being exhibited:—

Palmodictyon virida, *Vorticellidæ*, &c.	Mr. F. W. Andrew.
Alcyonella fungosa	Mr. C. Emery.
Antenna of moth, *Saturnia carpini*	Mr. F. Eneck.
Sections, Kola bean, *Cola acuminata*	Mr. H. Epps.
Poduridæ smynthurus	Mr. J. D. Hardy.

L.S. stem of *Helianthus*	Mr. A. W. Lyons.
Spider, *Pholcus phalangoides* ♂	Mr. G. E. Mainland.
Thistle bug, *Monanthia cardui*	Mr. R. T. G. Nevins.
Alcyonella fungosa	Mr. C. Rousselet.
Olivin basalt	Mr. G. Smith.
Lacinularia socialis	Mr. J. Spencer.
Wheel plates, *Chirodota violacea*...	Mr. W. Watson.

Attendance—Members, 51; Visitors, 5.

October 8th, 1886.—Conversational Meeting.

The following objects were exhibited:—

A new Rotifer	Mr. F. W. Andrew.
Wheat-flies, *Cecidomyia* sp.	Mr. F. Enock.
Leaf of China grass, *Conocephalus nivens* ...	Mr. H. Epps.
New Foraminifera from King George's Sound, W. Australia	Mr. H. F. Hailes.
Spider, *Dysdera Hombergii* ♀	Mr. G. E. Mainland.
Diatoms, *Pseudo-rutilaria monile*	Mr. H. Morland.
Head of Blow-fly	Mr. R. T. G. Nevins.
Pupa and imago of Dipteron sp.	Mr. R. T. G. Nevins.
Carchesium	Mr. C. de Pelley.
Monads, *Spirostomum ambiguum*, and Rotifer, *Anurea aculeata*	Mr. C. Rousselet.

Attendance—Members, 39; Visitors, 0.

October 22nd, 1886.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., in the Chair.

The Secretary called attention to the fact that as the President and Vice-Presidents were again absent, it devolved upon the members present, in accordance with Rule 4, to elect a chairman to preside on the occasion.

Mr. J. G. Waller having been proposed by Mr. Parsons, and seconded by Mr. Curteis, was elected chairman for the evening.

The minutes of the preceding meeting were read and confirmed.

Mr William Hampton was balloted for and duly elected a member of the Club.

The following additions to the Library were announced:—

"The American Naturalist"	In exchange.
"Proceedings of the New York Microscopical Society"	" "

"The Botanical Gazette"...	In exchange.
"Proceedings of the Hertfordshire Natural History Society"	" "
"Journal of the Royal Microscopical Society"...	" "
"Fifteenth Report of the South London Natural History Society"	" "
Part VI. of Dr. Hudson's "Rotifera"	Purchased.
"Annals of Natural History"	"

The Secretary said that he had been requested to announce that the Annual Soirée of the Croydon Microscopical Society would take place on November 17th, and that forms were placed upon the table for the use of any members of the Club who were desirous of responding to the invitation to assist on the occasion.

Mr. Spencer read a paper on *Zoothamnium arbuscula*, which he illustrated by drawings on the black-board.

The Chairman thought the communication was one of great interest, although not relating to a branch of microscopy to which he had given any personal attention. He hoped some other members would contribute further information upon it.

Professor Stewart said there was one point about the subject which appeared of special interest, and that was as regarded the splitting up of what was originally a membranous collar into individual cilia. He thought if this was so it would be an interesting question as regarded other infusoria which were provided with a vibratile collar, and he should be very glad to hear if any other observers present had noticed this process.

Mr. J. D. Hardy regretted that he had not been able to reach the meeting in time to hear the whole of the paper, but he could quite corroborate the fact as to this splitting process. Whenever he had observed it, he had always noticed that the fresh bell broke off, swam away and adhered by its ciliary processes, and that what was originally the lower portion of the animal formed the cilia in the new one.

Mr. Spencer said that Mr. Hardy's observation probably referred to some other species. He had never seen this himself, but might not have seen the bodies attach themselves because his trough was too large.

The thanks of the meeting were voted to Mr. Spencer for his paper.

The Chairman said that some new objectives had been sent by Dr. Carl Zeiss, of Jena, and called upon Mr. Curties to give some account of them.

Mr. Curties said he was glad to embrace that early opportunity of exhibiting to the Club the new apochromatic objectives and their eye-pieces recently introduced by Dr. Zeiss, knowing, as he did, the lively interest shown by the members in all matters relating to the use of, and improvements in, the microscope. He thought it would be unnecessary for him to occupy time in giving a detailed account of the apochromatics, as they were termed, as in the last number of the "Journal of the Royal Microscopical Society" would be found, through the kindness and by the aid of our Hon. Secretary, Mr. Karop, a full translation of the descriptive pamphlet just issued by Dr. Zeiss,

the pamphlet also being now in circulation. He begged permission, however, to offer a very few remarks on the subject. Prof. Abbé, to whom microscopists owed so much, together with Dr. Schott and Dr. Zeiss, commenced in 1881 a series of experiments in order to produce new kinds of glass, with the result that objectives could now be manufactured in which the so-called secondary spectrum was removed and the spherical aberration uniformly corrected; hence the application of the term *apochromatic*—a higher state of achromatism than had been hitherto obtained. These objectives, when used under the special conditions recommended, *i.e.*, exact length of body tube (160 millimètres for the Continental and of 250mm. for the English), and with their own proper eye-pieces, exhibit a marked improvement in definition, and in other particulars, notably long working distance, increased illumination, flatness of field, and a capacity for eye-piecing quite unusual in lenses of the old construction. For the proper use of these objectives, and for their more perfect correction, it has been found necessary to design new eye-pieces called "Compensating Oculars." These were of two kinds—"Finder" or "Searcher," and "Working." The first were of very low power; in fact No. 1 enabled an objective to be employed with its own magnifying power, the same as if it were used as a magnifier without an eye-piece. The working eye-pieces commenced with a power of four, and gave good results, even with the highest numbers. He thought there was little doubt but that the Finder or Searcher eye-pieces would supply a want long felt, as they afforded sufficient field of view for general examination, and would be of special service when immersion objectives were used, as the great inconvenience caused by having to change an objective, already adjusted, for one of lower power, could now be avoided. They were also arranged upon a method suggested by Professor Abbé, viz., on the increase in the total power of the microscope obtained by means of the eye-pieces, as compared with that given by the objective alone; for example, on the microscope now showing *A. pellucida* is the 3·0 mm. homo. immer. ($\frac{1}{8}$) objective, which of itself magnifies 83 diameters. The eye-piece employed is the No. 12, and magnifies 12 times. Now, if 83 be multiplied by 12, the result is 996, or say 1,000 as stated by the maker. There was another series called projection eye-pieces, which Mr. Curties stated could not be shown on that occasion, but he hoped to bring them to an early meeting and give a practical illustration of their value. They were intended for purposes of demonstration on a screen or for photo-micrography. He concluded by stating that upon the tables were arranged microscopes of English, and of Continental form, each supplied with a full series of the new objectives and eye-pieces, together with a number of familiar objects, by which the members of the Club would be able to form an opinion for themselves of these interesting and remarkable productions.

Mr. J. E. Ingpen said he did not know that he could add anything to the description given by Mr. Curties in his paper except of a technical nature, and, therefore, not likely to be of general interest. But he might mention that there was an editorial article in the April number of the Royal Microscopical Society's Journal which, together with what appeared in the

October number, would put the members of the Club in possession of the technical nature of the glass which was employed. It was not the first time they had been indebted to Professor Abbé for what they would otherwise have been most unlikely to obtain. In 1874 Abbé published the first of his remarkable series of treatises upon the definition of the microscope, and what great results had come from this they all knew. That work had now been supplemented by the present great addition to the optical means at their disposal. In the April number of the Royal Microscopical Society's Journal there was a short account of the manner in which these glasses were graduated, and it was very curious to find that after Professor Abbé and Dr. Schott had made their elaborate series of experiments they were disposed to leave them at that stage. Happily, however, they were induced to go on, and in connection with Dr. Zeiss, subsidised by the Prussian Government, the matter was carried on to its present results. He thought that at present the new glass was more likely to be used for astronomical purposes, seeing the very great complexity of the combinations for microscope objectives. One of the series contained as many as ten lenses, arranged in five systems, one of which was made of ordinary glass. The question of getting rid of the secondary spectrum had taken a great deal of attention at various times. Professor Stokes and others had worked at it, but he did not suppose that any such systematic and exhaustive experiments had ever before been applied to any optical theory. As regarded the new lenses, the improved definition, the increase of power and convenience in use were something perfectly astonishing, whilst the manner in which the objectives were supplemented by proper eye-pieces showed how extremely carefully the whole theory had been worked out into practice. It was Professor Abbé's peculiarity that he always perfected his formulæ in every detail before bringing it into practice, and in the case of these new lenses the whole scheme of every one had been entirely worked out beforehand. It was quite a new point of departure in practical optics, and it was impossible to say where it might lead to in the future.

A vote of thanks to Mr. Curties was unanimously carried.

Mr. Freeman said he had brought a series of sections of Spiders, cut by Mr. H. M. J. Underhill, of Oxford, who, a few years ago, wrote some articles on Spiders, and Diptera in "Science Gossip." Mr. Underhill had recently been cutting sections of the Garden spider, *Epeira Diadema*, and from a careful study of these sections had prepared a drawing, giving, what he believed to be, a correct representation of the internal organs in their natural position. Some of the results of his investigations had been given to the world in an article which appeared in "The Welcome" for the present month, a copy of which periodical was on the table. The principal drawing illustrating that article had been built up, as it were, from various sections taken in different directions through the Spider, it being evident that a single section would not convey a very comprehensive view of the interior economy of the creature. He (Mr. Freeman) had also brought the original drawings, which had been kindly lent by the editor of "The Welcome." The article

was written in a free and simple style, in order to interest the general public, and especially the young, but he thought it would be found interesting to many of the members. Mr. Underhill's chatty, though terse, style made the dryest details readable. In his next article he proposed to deal with the web-making, and web-making apparatus, of the spider. The sections were cut with an ordinary machine, and were remarkable not only on account of their anatomical value, but, like all Mr. Underhill's work, for their careful and methodical preparation. He (Mr. Freeman) remembered hearing Dr. B. T. Lowne, some years ago, suggest that a consecutive series of sections of the human spinal cord, from the top to the bottom, would be most instructive and valuable, and thought it could be done in a few hundreds of slides. Mr. Underhill had gone a good way in that direction, for some of his slides had as many as 60 distinct sections of a species of slug on a 3 × 1 slip. Of the Spider series some have as many as 32 sections on a slide, grouped with the greatest regularity. On seeing the article it occurred to him that some of the members of the Quekett Club would like to have an opportunity of examining the preparations themselves, and he therefore communicated with Mr. Underhill, who most kindly, perhaps somewhat rashly, sent some slides up for exhibition. He had asked Mr. Underhill to send one that would best illustrate the drawings. He said, in reply, "The fact is I have not one single *perfect* section. It is only by diligently comparing some number of slides that you can see all that I have put into the drawings. I think they are quite accurate."

The thanks of the meeting were voted to Mr. Freeman for his communication.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual Conversazione, and the following objects were exhibited:—

Palludicella Ehrenbergi	Mr. F. W. Andrew.
Dr. C. Zeiss's apochromatic objectives and compensating eye-pieces	Mr. C. Baker.
Cimex lectularia	Mr. F. Enock.
Sections of Garden Spider, *Epiera diadema*, prepared by Mr. H. M. J. Underhill ...	Mr. H. E. Freeman.
Larva of *Nepa cinerea*	Mr. R. T. G. Nevins.
Hairs of centipede, *Scolopendria paradoxa* ...	Mr. C. Rousselet.

Attendance—Members, 56; Visitors, 3.

November 12th, 1886.—Conversational Meeting.

The following objects were exhibited :—

Urocentrum turbo	Mr. F. W. Andrew.
Diatoms from Oamaru	Mr. A. Cottam.
Crenulate antenna of Moth ... ... *Pygera bucephala*, natural form and colour	Mr. F. Enock.
Human retina, normal	Mr. G. C. Karop.
Pyrgodiscus simplex	Mr. H. Morland.
Navicula disciformis, with ¼ apochromatic object glass	Mr. E. M. Nelson.
Fredericella sultana	Mr. C. Le Pelley.
Zoothamnium arbuscula...	" "
Anthodiscus floreatus (G. & S.), n.s. from Oamaru...	Mr. G. Sturt.

Atttendance—Members, 35 ; Visitor, 1.

November 26th, 1886.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced :—

"Annals of Natural History"	Purchased.
"British Desmids," Part V.	"
"British Petrography"	"
"The Rotifera," Part VI.	"
"The Botanical Gazette"	In exchange.
"Proceedings of the Geologists' Association" ...	"

The Secretary announced that the second part of Mr. Sturt's paper "On Diatom Structure" had been received, and would be taken as read that evening.

Mr. E. M. Nelson read a paper "On the New Apochromatic Lenses," in the course of which he explained, by the aid of diagrams, what was meant by the "secondary spectrum," which was said to be got rid of by the use of the glass of which these combinations were constructed.

Mr. Nelson also read a further paper "On a Method of Finding the General Character of a Cemented Combination," the subject being largely illustrated by means of diagrams.

Mr. John Mayall, jun., inquired if Mr. Nelson had, by any chance attempted to estimate the forms adopted by Zeiss in the new apochromatic objectives, so as to get an approximate idea of the combinations ?

Mr. Nelson said he had not yet had the opportunity of doing so, and had not referred to the matter because his paper was written before his return to town, and, therefore, previous to his having been able to see these lenses.

The President was sure that all present would join in thanking Mr. Nelson for his two very interesting communications, relating as they did to subjects upon which some people at least had rather misty ideas. He had not only given them a very clear description of what was meant by the secondary spectrum, but had in his second paper introduced them to what appeared to be an interesting method of obtaining some idea as to the combinations of an objective.

The thanks of the meeting were unanimously voted to Mr. Nelson for his communications.

The President said he had brought down to the meeting an object which he thought might be interesting to some of the members. It was not strictly microscopic, for although it was one of his "pets," it was a creature of appreciable size—one of the Argasidæ, the Persian *Argas* originally introduced to the notice of zoologists in 1823 by Fischer, who published an account of it in the Transactions of the Academy of Moscow. Fischer had been travelling in Persia, and had collected a large amount of information on Natural History subjects, and he gave a terrible account of this creature, whose bite, he said, produced violent fever, madness, and sometimes death in the course of 24 hours, and that it was particularly fatal to strangers. These remarks got abroad, and appearing in various works on Natural History and Entomology, became generally received as facts, especially as they appeared to receive confirmation from time to time by the reports of other writers. In 1858 Heller managed to obtain some specimens, his object being to study their anatomy, and he gave the results of his observations in the Transactions of the Vienna Academy of Sciences, giving also some very good figures of the creature. Nothing more seemed to transpire on the subject until 1878. A few years previous to this date the Shah of Persia wrote to the French Government to ask for a physician to be sent out to him at Teheran, and in response to this request Dr. Tholozan was appointed to the post, and was asked to collect and send home specimens of the Argasidæ. This he accordingly did, collecting them from Miana and other places. At Miana he found that at the present day they did not bear such a terrible reputation as that given to them by Fischer ; they were found in the neighbourhood, chiefly upon sheep, but were not thought to be dangerous. However, at another place he found that they were not only considered dangerous, but that they were called by the natives *Guérib-guez,* or "Strangers beware." Dr. Tholozan sent them to Laboulbène, and soon after they arrived he sent them on to Mégnin for examination. Mégnin was busy at the time, and put them aside in a drawer until he had time to attend to them, but forgetting what he had done with them, and being unable to find them, he had to tell Laboulbène that they were lost, and he in turn not liking to ask for more, the matter for the time ended there. Three and a half years afterwards, however,

Mégnin happening to turn out the drawer found the lost box, and on opening it, found, to his astonishment, that the creatures were still alive, and apparently nearly as active as usual. He then examined them carefully, and found that those which came from Miana were identical with those which had been described by Fischer, those which were considered harmless were of a different species, whilst those called "Strangers beware" were a mixture of the two species. Mégnin wrote a skilful paper upon the subject, but he wanted very much to know if they were really as dangerous as they had been made out to be, Dr. Tholozan having come to the conclusion that their bites, under certain conditions, favoured by the miasma of the place, would probably produce a state of affairs which might prove to be serious, but were not in themselves dangerous. Mégnin himself took one of the creatures and placed it upon his arm, when it bit at once and sucked blood until it was satisfied, and he found that the place where it had bitten continued to irritate, more or less, for about a fortnight, but no serious effect took place beyond. A short time ago he (the President) received a letter from Miss Ormerod, saying that she had received from Mr. Crawford, the State Entomologist of Adelaide, Australia, some specimens, asking her to identify them. She did not know the species, but seeing that one was an *Argas* threw them into boiling water and killed them at once, and then forwarded them to him to see if he could name them. He examined them as well as their condition permitted, and was entirely unable to see any difference between these and the Persian *Argas* described by Mégnin. He thought, however, that he should like to see them alive if possible, and so sent for some more, and in answer to his request Mr. Crawford sent him some—only two—by post from South Australia. They arrived whilst he was out of town, and so they were left for a month or six weeks without attention, but subsequently he found that one of them was still alive. He had mounted the other and had brought it to the meeting that evening together with the living specimen, both of which were exhibited under microscopes in the room.

Mr. H. Epps said he should like to make a few remarks on the subject of a new cement, but rather with the object of seeking information than of being able to give it. Perhaps some of the members might have noticed the letters which recently appeared in the "Times" on a new use for sugar, in which the writer pointed out that it formed an ingredient in a very hard cement, and claimed for the process great antiquity, stating that it was in use amongst the Romans, and in India in early ages, and then proceeded to give various suggestions for making a cement which should be harder than anything of the kind previously known. It struck him on reading this account that it might perhaps be a good cement for microscopical purposes, and therefore thought he would try how it worked. The directions were to mix together equal quantities of sugar and lime, and it was particularly emphasized that cane sugar should be used for the purpose. He had tried to follow the receipt as closely as possible, but was sorry to say that the results had proved to be very disappointing. He first took some ordinary cane sugar and endeavoured to mix it with lime and water, but he soon found

that this was not the way to proceed, as the sugar seemed to maintain its crystalline condition. He then tried dissolving some sugar in water until he got it highly saturated, afterwards adding the lime. By this process he seemed at first to get more satisfactory results, but the next morning he found the cement had come to an untimely end, with the exception of one specimen. In this case he had united two slips of glass with cement between them, and he tried to break them apart, but though he dropped them and broke the glass, the two surfaces did not separate, and he thought he had met with success; but on looking at them again on the previous evening he found that the cement had once more resolved itself into its original constituents, and the result was that he was no wiser than before. He had mentioned the matter to a sugar refiner, who told him that he thought the idea was quite a mistake, and that the action of sugar upon lime was simply a rotting action, as he frequently found in his factory when sugar happened to be dropped upon a cement floor. He thought, however, that notwith. standing his want of success, his experiences in the matter might be worth noting.

Votes of thanks having been passed to the President and to Mr. Epps for their communications,

The Secretary announced that as the date of their ordinary meeting in December fell this year on Christmas Eve it would be omitted. The next ordinary meeting would therefore be held on January 28, when, according to their new rules, nominations for officers and council to be elected at the meeting in February would have to be made. It was also announced that the usual annual dinner of the Club would take place at the Holborn Restaurant on the day following the Annual General Meeting of the Club.

The proceedings then terminated with the usual Conversazione, and the following objects were exhibited :—

Eurycercus lamellatus	Mr. F. W. Andrew.
Cladophora, with diatoms *in situ*	Mr. A. L. Corbett.
Diatoms mounted in cassia oil	Mr. C. L. Curties.
Generative organs of male Flea, dissected entire by Mr. Tatem	Mr. T. Curties.
Myriapod, *Julus pulchellus*, with parasitical acari attached	Mr. G. E. Mainland.
Argas persicus, from Adelaide, Australia, living	Mr. A. D. Michael.
Arachnoidiscus ornatus... ... ... *Actinoptychus splendens*	Mr. E. M. Nelson.
Scale of Podura (*Lepidocyrtus curvicollis*), with $\frac{1}{12}$th apochromatic homo. immer. N.A. 1.40 ... ... *Amphipleura pellucida*, with the same, and achro. imm. condenser	Messrs. Powell and Lealand.
Rotifer, *Polyarthra platyptera*	Mr. C. Rousselet.
Section of Quartzite from the Wrekin, Salop...	Mr. G. Smith.
Spicules of Gorgonia, Holothuria, &c.... ...	Mr. W. Watson.

Attendance—Members, 62; Visitors, 7.

December 10th, 1886.—Conversational Meeting.

The following objects were exhibited :—

Desmids, various	Mr. F. W. Andrew.
Head of Plumed Gnat, *Chironomus plumosus*, ♂	Mr. F. Enock.
Spider, *Walckenäera acuminata*, ♂	Mr. G. E. Mainland.
Diatoms, *Triceratium castellatum*	Mr. H. Morland.
Barbed spine of Sting Ray	Mr. S. H. Needham.
Diatoms in balsam, shown with lieberkuhn ...	Mr. E. M. Nelson.
Philodina, sp.	Mr. C. Le Pelley.
Rotifer, *Euchlanis triquetra*	Mr. C. Rousselet.
Granulite, Rosswein, Saxony	Mr. G. Smith.
Lherzolite, Haute Garonne	" "
Diatom, *Hemiaulus amplectans*, n.s.	Mr. G. Sturt.

Attendance :—Members, 32 ; Visitors, 0.

Q.M.C. EXCURSIONS, 1886.

April 10th.

List of Objects Found on the Excursion to the Gardens of the Royal Botanic Society of London, by Messrs. Bousfield, Dunning, Funston, Hardy, Kern, McIntire, A. D. Michael, Nevins, Oxley, Parsons, and Rousselet.

CRYPTOGAMIA. Algæ.

Gonium pectorale.
Pandorina morum.
Scenedesmus caudatus.
Spirogyra calospora.
,, *nitida.*
Zygnema stagnale.

Desmidiaceæ.

Closterium didymotocum.
,, *lunula.*
,, *moniliferum.*

Diatomaceæ.

Cocconema lanceolatum.
Synedra radians.

PROTOZOA.

Acineta mystacina.
,, *tuberosa.*
Actinophrys brevicirrhis.
,, *pennipes.*
,, *sol.*
,, *viridis.*
Actinosphærium Eichhornii.
Amœba diffluens.
,, *princeps.*
,, *radiosa.*
Amphileptus anser.
Anthophysa vegetans.
Astasia limpida.
Bursaria truncatella (?).
Chætonotus larus.
Codosiga botrytis.
Coleps hirtus.
Cothurnia imberbis.
Dileptus folium.
Enchelys.
Epistylis anastatica.
,, *flavicans.*
,, *plicatilis.*
Euglena acus.
,, *viridis.*
Halteria volvox.
Lacinularia olor.
Litonotus fasciola.
,, *Wrzesniowski.*
Loxophyllum meleagris.
Opercularia articulata.
,, *nutans.*
Phacus longicauda.
Phialina viridis.
Platycola longicollis.
Pleuronema coronata.
Podophrya fixa.
Pyxicola affinis.
Spirostomum teres.
Stentor Barretti.
,, *Mülleri.*

Stentor polymorphus.
,, *Rœselii.*
Strombidinopsis gyrans.
Stylonichia fisseta.
,, *mytilus.*
Trachelius ovum.
Trichodina pediculus.
Urocentum turbo.
Vaginicola crystallina.
Vorticella nebulifera.
Zoothamnium, sp.
PORIFERA.
Spongilla fluviatilis.
CŒLENTERATA. Hydrozoa.
Supposed polyp. stage of *Limnocodium Sowerbii.*
VERMES. Rotifera.
Brachionus Bakeri.
,, *pala* (= *Amphiceros*).
,, *polyacanthus.*
Eosphora aurita.
Euchlanis triquetra.
Floscularia campanulata.
,, *longicaudata.*
Limnias ceratophylli.
Lindia torulosa.
Melicerta ringens.
Monostyla bulla.
Notommata aurita.
Œcistes crystallinus.
Philodina citrina.
,, *erythrophthalma.*
Polyarthra platyptera.
Pterodina patina.
Rotifer macroceros, vel megaceros.
,, *vulgaris.*
Stephanops lamellaris.
Synchœta pectinata.
Annelida. Oligochæta.
Æolosoma album (sp. nov.).
,, *quaternarium.*
,, *tenebrarium.*
Chætogaster minutus (sp. nov.).
Dero furcata.
,, *limosa.*
,, *Perrieri.*
Nais elinguis.
Pristina (sp. nov.).
MOLLUSCOIDEÆ. Polyzoa.
Fredericella sultana.
INSECTA.
Notospis lacustris, nymph of.

The day was very showery, but, in spite of the bad weather, the party numbered forty-one, of whom seven were members of other Societies and eight were visitors.

May 1st.

Objects Found on the Excursion to Totteridge, by Messrs. Dunning, Funston, McIntire, Mainland, Parsons, and Rousselet.

CRYPTOGAMIA. Algæ.
Chætophora elegans.
Gonium pectorale.
Pediastrum Boryanum.
Raphidium falcatum (= *Ankistrodesmus falcatus*).

Spirogyra communis.
Stigeoclonium elongatum.
Volvox globator.
DESMIDIACEÆ.
Arthrodesmus octocornis.
Closterium acerosum.
„ *lunula.*
„ *moniliferum.*
Hyalotheca dissiliens.
Micrasterias rotata.
Staurastrum gracile.
Xanthidium fasciculatum.
PROTOZOA.
Acineta, sp.
Actinosphærium Eichhornii.
Amphileptus fasciola.
Anthophysa vegetans.
Arcella vulgaris.
Chætonotus larus.
Coleps hirtus.
Difflugia pyriformis.
Dileptus folium.
Euglena viridis.
Stentor Eichhornii.
Stentor Mülleri.
„ *polymorphus.*
Trachelius lamella.
Uvella virescens.
Vorticella nebulifera.
„ sp., probably *alba.*
This and the *Acineta* were growing on *Daphnia Schæfferi.*
VERMES. ROTIFERA.
Brachionus pala (=*B. amphiceros*).
Colurus deflexus.
Distemma forficula.
Floscularia cornuta.
Monura dulcis.
Rotifer macrurus.
„ *vulgaris.*
Stephanoceros Eichhornii.
CRUSTACEA. ENTOMOSTRACA.
Cypris reptans.
Daphnia Schæfferi.
INSECTA. COLEOPTERA.
Dytiscus marginalis, larva of
DIPTERA.
Corethra plumicornis, larva of.
NEUROPTERA.
Agrion puella.
Ephemera vulgata.

Attendance : Sixteen members of the Quekett Club and four members of other Societies.

May 15th.

OBJECTS FOUND ON THE EXCURSION TO WOOD STREET, BY MESSRS KERN, PARSONS, AND ROUSSELET.

CRYPTOGAMIA.
ALGÆ. DESMIDIACEÆ.
Closterium moniliferum.
Penium Brebisonii.
PROTOZOA.
Carchesium polypinum.
Cyrtostomum leucas.
Enchelys farcimen.
Epistylis anastatica.
„ *flavicans.*
Litonotus Wrzesniowski.
Platycola longicollis.

Spirostomum ambiguum.
Trachelius ovum.
Uroglena volvox.
VERMES. Rotifera.
Anuræa aculeata.
Brachionus pala.
Conochilus volvox.
Mastigocerca rattus.
Melicerta ringens.
Notops hyptopus.
Œcistes pillua.
,, *umbella.*
Polyarthra platyptera.
Rotifer megaceros.
Stephanoceros Eichhornii.
Synchæta pectinata.

Attendance: Eleven members of the Quekett Club and five members of other Societies.

May 29th.

Objects Found on the Excursion to Whitstable, by Messrs. Dunning, Hembry, Priest, and Spencer.

PROTOZOA. Foraminifera.
Miliolina seminulum.
Polystomella crispa.
,, *umbiliculata.*
Rotalina beccarii.
PORIFERA.
Grantia ciliata.
,, *compressa.*
Halichondria panicea.
Hymeniacidon, sp.
Leucosolenia botryoides.
CŒLENTERATA. Hydrozoa.
Halecium halecinum.
Laomedia geniculata.
Plumularia setacea.
Sertularia argentea.
,, *pumila.*
Tubularia indivisa.
ECHINODERMATA.
Ophiocoma rosula.
Ophiura texturata.
Solaster papposa.
Uraster, sp.
CRUSTACEA.
Phoxichilidium coccineum.
Male and female.
Phoxichilidium littorale.
MOLLUSCOIDA. Polyzoa.
Bicellaria ciliata.
Bowerbankia imbricata.
Bugula avicularia.
Crisia eburnea.
Serialaria lendigera.
Valkeria cuscuta.

Attendance: Sixteen members of the Club and eight members of other Societies.

June 5th.

OBJECTS FOUND ON THE EXCURSION TO STAINES, BY MESSRS. KERN, PARSONS, AND ROUSSELET.

CRYPTOGAMIA.

ALGÆ. DESMIDIACEÆ.

Closterium didymotocum.
„ *moniliferum.*

CHARACEÆ.

Chara vulgaris.

PROTOZOA.

Anthophysa vegetans.
Chætonotos larus (?).
Dendromonas virgaria.
Dinobryon sertularia.
Epistylis anastatica.
Loxophyllum meleagris.
Ophridium versatile.
Stentor Mülleri.
„ *polymorphus.*
Trachelocerca olor.
Vaginicola crystallina.
Vorticella campanula.
„ *chlorostigma.*
„ *fasciculata.*

VERMES. ROTIFERA.

Asplanchna Brightwellii.
Dinocharis tetractis.
Euchlanis triquetra.
Floscularia campanulata.
„ *ornata.*
Hydatina senta.
Mastigocerca bicornis.
Melicerta ringens.
Œcistes crystallina.
Polyarthra platyptera.
Synchæta pectinata.
Stephanoceros Eichhornii.

Attendance : Nine members of the Club and three members of other Societies.

June 19th.

OBJECTS FOUND ON THE EXCURSION TO RYE HOUSE, BY MESSRS. RANSOM AND PARSONS.

CRYPTOGAMIA.

ALGÆ. DIATOMACEÆ.

Cocconeis placentula.
Cymatopleura apiculata.
„ *elliptica.*
„ *Solea.*
Cymbella Helvetica.
Diatoma elongatum.
„ *vulgare.*
Gomphonema acuminatum.
„ *constrictum.*
„ *curvatum.*
Melosira varians.
Nitschia linearis.
„ *sigmoidea.*
Pleurosigma attenuatum.
Surirella biseriata.
Synedra radians.
„ *Ulna.*
Tryblionella angustata.

PROTOZOA.

Amphileptus anser.
Astasia limpida.
Carchesium epistylides.

Cercomonas longicauda.
Chætonotus larus (?).
Coleps hirtus.
Epistylis nutans.
Peridinium, sp.
Stentor Mülleri.
,, *polymorphus.*
Vorticella chlorostigma.
,, *longifilum.*

VERMES. ROTIFERA.
Floscularia regalis.
Œcistes crystallina.
Polyarthra platyptera.
Pterodina patina.
Sacculus viridis.
ANNELIDA. OLIGOCHÆTA.
Æolosoma quaternarium.

Attendance: Ten members of the Club and four members of other Societies.

July 3rd.

OBJECTS FOUND ON THE EXCURSION TO WALTON, BY MESSRS. DUNNING, KERN, PARSONS, AND WESTERN.

CRYPTOGAMIA. ALGÆ.
Pediastrum Boryanum.
DESMIDIACEÆ.
Closterium moniliferum.
PROTOZOA.
Anthophysa vegetans.
Carchesium polypinum.
Chætonotus larus.
Dendrosoma radians.
Dileptus folium.
Epistylis anastatica.
,, *flavicans.*
,, *nutans.*
Folliculina elegans (?).
Phacus longicaudus.
Podocyathus diadema.
Stentor Mülleri.
,, *polymorphus.*
Stichotricha (?), sp.
Stylonichia mytilus.
Trachelius ovum.
Vaginicola crystallina.
VERMES. ROTIFERA.
Brachionus Bakeri.
Cephalosiphon limnias.
Euchlanis dilatata.
Floscularia campanulata.
,, *cornuta.*
,, *ornata.*
Lacinularia socialis.
Limnias ceratophylli.
Mastigocerca carinata.
Melicerta ringens.
Œcistes brachiatus.
,, *crystallina.*
Philodina citrina.
Pterodina patina.
Rotifer megaceros.
,, *tardus.*
,, *vulgaris.*
Stephanoceros Eichhornii.
TARDIGRADA.
Tardigrada, sp.
ANNELIDA.
Æolosoma quaternarium.
Stylaria, sp.

Attendance: Thirteen members of the Club and two members of other Societies.

July 17th.

OBJECTS FOUND ON THE EXCURSION TO GODSTONE, BY MESSRS. DUNSTALL, KERN, AND PARSONS.

CRYPTOGAMIA.

ALGÆ. DESMIDIACEÆ.

Closterium moniliferum.

PHANEROGAMIA.

Anchusa arvensis.
Anthyllis vulneraria.
Atropa belladonna.
Campanula trachelium.
Chelidonium majus.
Chlora perfoliata.
Echium vulgare.
Epipactis latifolia.
Euphrasia officinalis.
Hypericum hirsutum.
Lathyrus pratensis.
Malva moschata.
Ophrys apifera.
Spirea ulmaria.
Vicia cracca.

PROTOZOA.

Bursaria truncatella.
Carchesium polypinum.
Chloropeltis hispidula.
Difflugia proteiformis.
Epistylis anastatica.
Trachelocerca olor.

VERMES. ROTIFERA.

Brachionus pala.
Notommata aurita.
Œcistes crystallina.
Philodina citrina.
Plagiognatha hyptopus (? *Notops hyptopus*).
Pterodina patina.
Rotifer vulgaris.

MOLLUSCOIDEÆ. POLYZOA.

Alcyonella fungosa.

Only three members of the Club and one member of the Hackney Society attended, the morning being wet up to time of departure from town. The afternoon was very fine.

September 4th.

OBJECTS FOUND ON THE EXCURSION TO RICHMOND, BY MESSRS. HARDY, KERN, PARSONS, AND WESTERN.

CRYPTOGAMIA.

ALGÆ. DESMIDIACEÆ.

Closterium cynthia.
,, *didymotocum.*
,, *Kutzingii.*
,, *lineatum.*
,, *lunula.*
,, *moniliferum.*
,, *setaceum.*
Docidium baculum.

PROTOZOA.

Actinophrys sol.
Anthophysa vegetans.
Chætonotus larus.
Codosiga botrytis.
Difflugia proteiformis.
Dinobryon sertularia.
Euglena oxyurus.

Holophyra ovum.
Litonotus fasciola.
Stentor Mülleri.
Stichotricha secunda.
Trichodina pediculus, on hydra.
Uvella virescens.
Vaginicola crystallina.

VERMES. Rotifera.
Cephalosiphon limnias.
Dinocharis pocillum.
„ *tetractis.*
Floscularia campanulata.
„ *cornuta.*
„ *ornata.*
Furcularia æqualis.
„ *longiseta.*
Mastigocerca bicornis.
Melicerta conifera.
„ *rigens.*
Microcodon clavus.
Noteus quadricornis.
Œcistes crystallina.
„ *longicornis.*
Plagiognatha hyptopus (? *Notops hyptopus*).
Polyarthra platyptera.
Pterodina patina.
Rattulus tigris.
Rotifer megaceros.
„ *tardus.*
„ *vulgaris.*
Sacculus viridis, with two eggs attached below.
Scaridium longicaudum.
Stephanoceros Eichhornii.
Synchæta tremula.
Taphrocampa selenura, swimming with auricles expanded.

CRUSTACEA. Entomostraca.
Sida Crystallina.

MOLLUSCOIDEÆ. Polyzoa.
Alcyonella fungosa.
Plumatella repens.

Attendance: Six members of the Club and five members of other Societies.

September 18th.

Objects Found on the Excursion to Hayes, by Messrs. Epps, Kern, Parsons, and Spencer.

CRYPTOGAMIA. Algæ.
Batrachospermum moniliforme.
Chætophora tuberculosa.

Desmidiaceæ.
Closterium acerosum.
„ *Dianæ.*
„ *lunula.*
„ *setaceum.*
Euastrum oblongum.
Micrasterias denticulata.
„ *rotata.*
Penium digitus.
Tetmemorus granulatus.
Xanthidium armatum.

Diatomaceæ.
Cocconema lanceolatum.
Diatoma vulgare.

Gomphonema acuminatum.
Hyalosira rectangulata..
Pinnularia nobilis.
Surirella bifrons.

PHANEROGAMIA.

Calluna vulgaris.
Drosera rotundifolia.
Hydrocotyle vulgaris.
Hypericum Elodes.
Hypericum quadrangulum.
,, *humifusum.*
Narthecium ossifraga.
Reseda lutea.
&c., &c.

PROTOZOA.

Actinosphærium Eichhornii.
Bursaria truncatella.
Carchesium polypinum.
Difflugia proteiformis.
Dinobryon sertularia.
Epistylis anastatica.
Litonotus fasciola.
Stylonichia mytilus.

VERMES. ROTIFERA.

Euchlanis triquetra.
Floscularia ornata.
Monocerca rattus.
Noteus quadricornis.
Notommata Naïas.
Rotifer megaceros.
,, *tardus.*
Salpina redunca.
Taphrocampa annulosa.
Triarthra longiseta.

TARDIGRADA.

Macrobiotus Hufelandii.

Attendance : Nine members of the Club and eight members of other Societies.

October 2nd.

OBJECTS FOUND ON THE EXCURSION TO CHINGFORD, BY MESSRS. EPPS, LE PELLY, PARSONS, AND ROUSSELET.

CRYPTOGAMIA. ALGÆ.

Chætophora elegans.
Scenedesmus quadricauda.

DESMIDIACEÆ.

Closterium setaceum.
Micrasterias rotata.
Penium closterioides.

PROTOZOA.

Acinetæ, various forms.
Actinophrys sol.
Anthophysa vegetans.
Carchesium polypinum.
Chætonotus larus.
Coleps hirtus.
Epistylis plicatilis.
Euglena acus.
,, *viridis.*
Glenodinium tabulatum.
Loxophyllum meleagris.
Paramecium aurelia.
Platycola longicollis.
Podophrya fixa.
,, *quadripartita.*
Spirostoma ambiguum.
Stentor polymorphus.
Stichotricha (?), sp.
Stylonichia pustulata.
Trichodina pediculus.
Vaginicola crystallina.
Vorticella nebulifera.

Zoothamnium arbuscula.

VERMES. Rotifera.

Anuræa aculeata.

Cephalosiphon limnias.

Colurus deflexus.

Diglena lacustris (?).

Dinocharis tetractis.

Diplois Daviesiæ (?).

Distemma forficula.

Floscularia campanulata.

,, *cornuta.*

,, *ornata.*

Limnias ceratophylli.

Mastigocerca carinata.

Melicerta ringens.

Metopidia rhomboides.

Polyarthra platyptera.

Rotifer megaceros.

,, *vulgaris.*

Sacculus viridis.

Scaridium longicaudum.

Synchæta pectinata.

Triarthra longiseta.

ARACHNIDA.

Chelifer, sp.

MOLLUSCOIDEÆ. Polyzoa.

Fredericella sultana.

Lophopus crystallinus.

MYRIOPODA.

Polyxenes lagurus.

INSECTA. Diptera.

Corethra plumicornis, larva of.

Attendance: Nineteen members of the Club and six members of other Societies.

Fredk. A. Parsons,
Hon. Sec. Excursions Sub-Com.

On the Finer Structure of Certain Diatoms.

Part II.

By E. M. Nelson and G. C Karop.

Plate IV.

(Taken as read January 28th, 1887.)

Since our last paper on this subject (read March 26th, 1886) an achromatic oil immersion condenser has been made by Mr. T. Powell, Mr. Nelson having, in 1882, suggested to him the necessity for achromatising the then chromatic oil condenser. This has enabled us to illuminate objectives by solid axial cones of larger angle than before; the spherical aberration of a chromatic condenser being so great that only the rays passing through the centre or through a narrow zone of the condenser could be focussed on the object at one time. The result has been a marked increase in resolution. In illustration of this increased resolution we would refer you to Fig. 6, which is a drawing of an areolation of the same valve of *Isthmia nervosa*, which we figured in our former paper (Plate 17, Fig. 2. Series II, Vol. ii). The straight bars of silex by which the central delicate perforated membrane was shown to be attached to the margin of the areolation now have a trabecular appearance; the delicate membrane extends to the edge of the large areolation, and has perforations more difficult to resolve than those in the centre. We wish to point out that this is not a correction of misinterpretation of optical images, but a clear case of increased resolution, due to an improvement in optical appliances. Even now we do not wish to lay any claim to finality, but to show that every advance in perfecting instrumental appliances is attended by an increased gain in our knowledge of structure. In addition to the new condenser, we have used Professor Abbé's new compensating eye-pieces, which give sharper images than those of the Huyghenian construction. Before proceeding further we wish to record our great obligation to Mr. G. Sturt for the very kind way in which he has placed his magnificent collection of diatoms at

our disposal, and for his assistance in naming the specimens. We are indebted to him for the specimens figured 1, 2, 5, 7, 8, 9.

1. *Coscinodiscus centralis* exhibits a very beautiful structure. The bars of the so-called hexagonal, or coarse structure, which are more delicate than usual, are seen lying over the finer perforated membrane. In some instances a bar of the coarse structure bridges over a perforation in the lower structure. Average diameter of coarse areolation ·0000957 inch.

2. *Bacteriastrum varians*, showing fine, thorn-like points arranged spirally round the ray. The length of the thorn is $\frac{1}{200000}$ inch, assuming it to be one-tenth of the diameter of the ray.

3. *Euphyllodium spathulatum.* The coarse areolations are filled up with a structure of very unusual form, some of the minuter perforations reminding one of telescopic glimpse-objects. Diameter of coarse areolation, ·0000904 inch.

4. *Arachnoidiscus Ehrenbergii*, showing points projecting into the areolation from its edge; some varieties of this diatom have a more elaborate pattern. Diameter of areolation, ·000117 inch.

5. Stalk of *Kittonia elaborata*, exhibiting a delicate perforated membrane, covering the bell-shaped end of the pipe. This curious appendage resembles in miniature the rose of a watering-pot. Major axis, ·00135 inch. The tube-like processes or feet at the angles of the *triceratia* have minutely perforated caps to them. Those on *Triceratium fimbriatum* are not so easy to resolve.

6. *Isthmia nervosa*, described above. Major axis, ·000274 inch. There is a very minutely perforated membrane in the smaller areolations on the hoop of this diatom—a test.

7. Fragment from Brünn deposit. A very beautiful but unusual pattern, which we have named the fiddle-pattern, on account of its resemblance to the *f* marks on a fiddle. Major axis, ·000202 inch.

8. Fragment from Brünn. Major axis, ·000283 inch.

9. *Aulacodiscus Sturtii*, showing a secondary pattern outside the primary. In all the examples we have hitherto brought before you the secondary structure has been inside the primary. This diatom, however, in common with several of the *Aulacodisci*, has its secondary pattern exterior to its primary. Diameter of primary structure, ·0000478 inch.

10. *Asterolampra vulgaris.* The well-known fine lacework of

Fig 1.

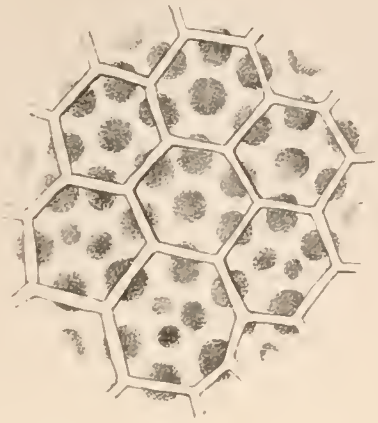


Fig 2.

Fig 3.

Fig. 4.

Fig 6.

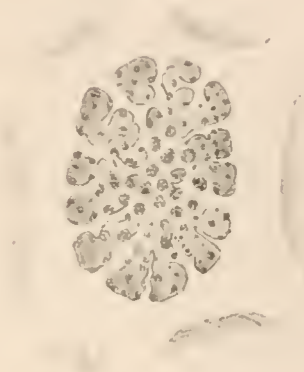


Fig 5

Fig 7.

Fig. 8.

Fig 9.

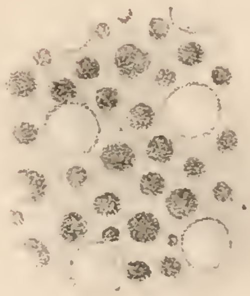
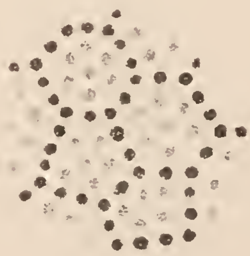


Fig. 10.

Fig. 11.



G. C. Karop del.

West, Newman & Co lith.

this beautiful form has a still more minute tracery inside each areolation. How truly marvellous this is when we consider that the coarse areolation only measures ·0000727 inch in diameter.

11. *Aulacodiscus Kittonii.* Eight rays. Peru. This diatom does not resemble the *A. Sturtii* in the peculiarity mentioned above, but follows the usual type of diatoms in having its secondary pattern inside the primary. Delicate structure will also be noticed between the coarse areolations; this specimen, therefore, is a sort of compromise between the peculiar *Aulacodiscus* structure and the usual type. It is very delicate, but not so small as No. 10, the large areolation measuring ·0000798 inch.

The objective used for the work in this and our former paper was an achromatic oil immersion, $\frac{1}{12}$, 1. 43, N.A., by Powell. The magnification generally adhered to was 1200 diameters.

THE PRESIDENT'S ADDRESS.

Delivered at the Annual General Meeting, 25th February, 1887.

By A. D. Michael, F.L.S., F.R.M.S., &c.

It may be objected that the subject which I have chosen for my address to-night is not microscopical; this is to a certain extent true, but the great use of the microscope is to investigate nature; for, although it is possible for man to manufacture articles so fine in their structure and markings that the very highest powers of our favourite instrument are required for their examination, yet the vast majority of his works are so coarse that the assistance of any considerable amplification is quite unnecessary. It is practically for nature alone that the microscope is used, and I do not think that I am going too far if I say that it is applied twenty times upon biological objects for once that it is employed on all others taken together; therefore, no subject which is of deep and general interest to biologists can be inappropriate for discussion at a gathering of workers with the microscope such as the present. It may also be objected that the subject is old; so are most other subjects; what there may be new above the sun we are not told, but we are credibly informed that there is not anything new under it; and novelty is scarcely expected in a President's address, it is usually a review of something that has been done, either of the work of the year in the particular branch or of something else: new discoveries are probably more fitly reserved for papers, where others who are not members of the particular society are more likely to look for them. But again it may be said, and justly said, that this question is not only old, but that it has been discussed and treated of so fully and exhaustively by the very ablest men that science possesses, both in this and in every other civilized country, and even in every nook and corner of each country, that it is utterly hopeless to bring forward any new facts of importance without fresh discoveries; or even to put the old facts, or any of

them, in any light which has not been turned upon them over and over again; and that it is even presumptuous in a mere amateur naturalist to dream that he has any chance of doing so: I for one am not under any such delusion. I am fully aware that everything I have to say has been said before, and many times before, by those who could say it far better than I can; but it has not been said *ad nauseam*, for that implies that everyone is weary of it, whereas it is the characteristic of this particular subject that it does not pall upon its hearers, and that it still has about it that wonderful attraction which draws men to it as a candle draws the moths: I feel that attraction so strongly that I am not inclined to resist it, but I will rather rely on the existence of a like feeling in my hearers to make my very stale remarks of interest to them.

You will doubtless before now have concluded that there is only one subject upon which I can possibly speak as I have done, namely that upon which the literature has become so voluminous that in the catalogue of zoological books for sale published by Messrs. Pietzcker, of Trubigen, after the ordinary headings of "*Insecta*," "*Crustacea*," "*Vertebrata*," &c., will be found a special division headed "DARWINISMUS." Now it seems to me that, although I have not anything new to say, we may spend half an hour not disagreeably, nor unprofitably, in reviving our recollections of what has already been said, and of a few of the interesting facts and features with which the whole subject literally bristles. Nor is the present an undesirable time for doing so. It is the general history of important and far-reaching new ideas that they are at first received with surprise and something like amusement; then with bitter hostility, in spite of which they gradually win their way, if they be sound; then comes a period of fair consideration, when what is good in them becomes more generally acknowledged, and their cause is won. After this there arises a danger of a totally different class; the friends and disciples, through whose exertions the triumph has been obtained, have in the hour of struggle acquired an enthusiasm which is not easily satisfied; others join them, and the original theory is often pushed far beyond what its originator ever intended. The idea is all-engrossing, everything must bend to it, or be explained by it; and it is apt to be pushed far beyond its legitimate conclusions. Then, in the minds of many thinking men, comes a revulsion of feeling. Unable to follow the exponents of the new idea in their extreme deductions,

they are apt to lose sight of the dividing-line between the original foundation and the superstructure which later and more enthusiastic builders have erected upon it, and to condemn both together; thus the thoroughly sound original proposition is often endangered by the eagerness of its advocates. It seems to me that this is rather the position of the Darwinian theory to-day; its able supporters have carried it very far indeed, carried it into many things which were not originally contemplated, and which, although they are none the worse for being beyond the original conception, are certainly different, and may or may not be true. There are, amongst many others, two main lines in which this may be, and is, done. Firstly, it is strenuously asserted, by biologists whose names are sufficient to ensure respect for all they say, that every consistent evolutionist must admit that the process did not commence at the lowest form of life, but that the springing of life itself must be accounted for in the same manner. Now, at this point I am compelled to part company with the evolutionists. I cannot think that science requires us to believe that of which there is not any evidence whatever, and the reasons for which must, it seems to me, be purely speculative and deductive. I fail to see one iota of evidence of any change of non-living matter into living matter, except through the agency of life; and it is, I think, generally admitted that Dr. Bastian's long and able researches have not supplied the want. I am not aware that any progress whatever has been made towards obtaining such evidence, for I cannot regard the facts of crystallization as in any way analogous to those of life; and, until such evidence be supplied, I should prefer to adopt the Scotch verdict of "not proven." It may be true, or it may not; it appears to me that we simply do not know anything about it. I am fully aware that this is a confession of ignorance, and of the entire impotence of present science, with regard to the greatest of all natural questions; but surely this is not a reason for putting forward an explanation which cannot be justified by any proof whatever. It is not the only great problem of nature which we cannot solve; indeed, I am not sure that we are not in the same position as to all the greatest. Who will give us any sound or reliable information as to what life is, or what is that subtle something that departs when an animal dies? (Of course, in accordance with the rules of this Society, I am leaving the religious side of this and all other questions

entirely undiscussed and untouched.) Who will give us any tangible ideas as to the commencement or end of time, or enable us to conceive either that space is infinite, or that there is a limit to it? Bailey, in his poem of Festus, has a passage, "all points are central to the infinite," that is demonstrably true, but which of us can really picture to his mind that to which all points are central? On the other hand, a limit is beyond our conception. When our fathers were boys a question was asked of them which is as difficult to answer to-day as it was then—If you stood on the edge of space could you stretch out your hand, or could you not; if you could where would you stretch it to; if you could not what would stop you? It is, therefore, not any slur upon biological science that it cannot explain the origin of life, and it cannot surely be desirable to strain evolution in order to do so until we have some evidence on the point.

The second path along which Mr. Darwin's followers may be tempted too far is in the endeavour to explain every biological fact by survival of the fittest or sexual selection. It may be that there is such an explanation, but that we cannot discover it. The web is often difficult to unravel, yet almost every naturalist who observes a new fact feels not only that there must be some such explanation but also that it is incumbent upon him in particular to find it out, and there is a feeling of disappointment if he cannot frame a theory satisfactory to his own mind. We all of us feel this, and I confess that I, amongst others, naturally think when I observe something which I had not previously noticed, "Now how can I explain this?" but the feeling certainly has a tendency to produce far-fetched explanations when simpler ones are not easily found. I will give two or three instances of what I mean, and I must expressly premise that I do not in any way assert that these explanations are wrong; they may all be perfectly correct, but I quote them simply to show how incumbent men feel it upon them to give explanations of this nature of obscure phenomena. The first example I will purposely take from a work of the highest authority, in which we must all admire both the great ability and patient study. In Weismann's "Studies on the Theory of Descent," he gives an explanation of two spots, one on each side of the third segment of the larva of one of the foreign *Sphingidæ* (*Deilephela*); these he calls eye-spots; they are large brown spots, surrounded by light and dark rings. When touched, this

caterpillar does not raise the fore part of its body in the mode common amongst the larvæ of *Sphingidæ*, but withdraws the first and second segment within the third, which becomes distended; and remains motionless. Weismann considers that this is to terrify an assailant, and thinks that the third segment would look like an enormous head with great glaring eyes, and would have a very alarming effect: he tried putting the larva in a saucer in his garden; but the sparrows, after an inspection, thought discretion the better part of valour and beat a retreat. Weismann suggests that these eye-spots have been formed by survival of the fittest out of the smaller ring-spots. It strikes one that when these eye-spots were rudimentary at their first commencement they cannot have had a very alarming effect; also that the theory scarcely explains the similar spots which sometimes exist on the posterior segments, and that eye-spots are very like ring-spots which often exist on nearly all the segments; and that the withdrawal of the anterior segments into the more posterior ones is common with other caterpillars which have no eye-spots, and other arthropods when alarmed, and may well serve for the protection of the head; also that lying still has a family-likeness to shamming-dead. It must be admitted, however, that the ordinary rearing position of *Sphinx* larvæ when alarmed is probably a threatening attitude. Weismann does not say whether he tried if sparrows would eat other equally large larvæ. The other two instances I will take from papers recently read before our own Scientific Societies. A zoologist lately submitted to the Zoological Society that the comb of the cock, and other male gallinaceous birds, was beneficial to the species because the males were in excess of the females; and in the conflicts of the males the comb was a very attackable part, and enabled them to kill each other more frequently than they would do were it absent. We might at first think that the apparent scarcity of the female is due to its more sombre colour, more stay-at-home habits, and to such remarkable provisions for concealment in the females of ground-nesting birds as the loss of scent at the time of incubation, which causes a pointer to pass close by a sitting pheasant without discovering it; but Indian ornithologists agree that the disproportion in the number of males to females is greater than these causes will account for; while poultry-keepers usually prefer having three hens to one cock; but it seems difficult to see how the comb-theory can operate, as, according to it, the cock with

a large comb would have least, not most, chance of having descendants; and, again, if the preponderance of males be hurtful why has not it or the species died out? The last instance was submitted, very doubtfully and tentatively, to the Linnean Society. A botanist, introducing a new fungus which had "a pleasant meaty smell," suggested that there was some reason to suppose that some agarics only germinated after passing through the alimentary canal of animals, and that possibly this smell induced beasts to eat it, which may be true, but at the first blush it scarcely seems apparent why a lion should eat fungi, or why a deer or an ox should be attracted by a meaty smell. At any rate it appears to me that at present these extreme advancements of the Darwinian theory have produced a distinct tendency to recoil from it in the minds of many excellent biologists.

I have purposely used the popular expression "Darwinian theory," because in the minds of those who are not naturalists it usually includes two things. If we speak to our non-scientific friends we shall probably find that most of them by "Darwinian theory" mean something which Darwin never claimed and never could have claimed, something the idea of which had arisen in men's minds long before Darwin, namely evolution; it is really that, and not Darwin's "survival of the fittest," that is popularly objected to. I need scarcely point out to you that they are totally different things. If a man who had not ever seen a watch or a steam engine suddenly found one in action he would probably conclude, without much difficulty, that it had been manufactured by man, that it had not grown on a tree, or been formed by crystallization, but when he came to form a theory as to the precise mode of manufacture he would probably be very far out. In the same way it is quite conceivable that evolution might be correct, but that the beautiful explanation of the mode by which it has been attained, which we owe to Darwin and Wallace, might be erroneous: but the converse will not hold good; if evolution were a myth the explanation would fail of itself. Therefore in considering the Darwinian theory we must necessarily consider evolution first; but it may fairly be said that it is unnecessary to do this, because probably no biologist of importance now denies the truth of evolution, the surviving objection being confined to those who have not paid any attention to the subject, but who think that it is somehow degrading to them to be cousin to a monkey, no matter how many times

removed. This would be a perfectly good reason if I were addressing a more deeply-learned Society, but ours is one where we need not be ashamed of amusing ourselves by talking over some of the interesting developments of life, even if they be generally admitted.

It seems to me that the one great fact which proves evolution, and which cannot reasonably be explained in any other way, is the almost universal tendency of different forms of life to run into series, both as to species and genera and as to the adaptation of homologous organs. It is this only which enables us to classify fauna and flora as we do. Take almost any order of plants or animals, it matters not what, and we find a great number of more or less similar forms, similar not merely in the great facts of their structure, but in all sorts of even trifling points; these points being more developed in one species than in another, sometimes almost rudimentary, but almost always present in some degree. Take up the table for identification of species in almost any monograph, and it will strike you at once how the ingenuity of the author has been taxed to find tangible distinctions between closely-allied species, and how he is enabled to work down from the general to the particular by most of the species usually having many, even trifling, characters in common. The *Diptera* are excellent examples; take up Walker's *Diptera* and see what occurs even with the British species: try to identify a gnat which you do not know; you will find a long series of species so similar that the table for identification is appalling. Again, why should the possession of a bi-lobed tongue furnished with pseudo-trachea be so much correlated with two effective wings and two poisers, there are plenty of other forms of sucking mouth? Why should almost all Sphinx larvæ have a curved spine in the middle of the last segment of the body? Why should the number of spines on the respective segments of the larva of all the species of Vanessa butterflies be almost constant? Why should the tracheæ be developed into leaf-like organs, the so-called lungs, in all scorpions and so many spiders and not in anything else? Why should two parallel blade-like ridges (the lamellæ) run along the cephalo-thorax of about half the *Oribatidæ*, each ridge bearing a hair at its end? Why should a trace of the ridge be found in almost all the other species, and why should the hair sometimes persist in the instances where the ridge cannot be detected?

Why should there be a long tactile hair on the front tibia of almost all blind *Acari*; it is an excellent place for it, but there are other good places also, and the hair often occurs on the other tibia which are not such good places? How can such facts as these, and the thousands upon thousands of similar instances, be explained except by community of descent? An excellent example was pointed out by Professor Flower in his Hunterian lecture on the subject, viz., the reduction in size of the second and third digits in all Australian Marsupials notwithstanding their widely different habits; it can hardly be supposed that the shortening of these two fingers has arisen separately in all the species. Then, again, the diverse adaptations of the same morphological part tell the same story. The oft-quoted adaptation of the fore limbs of Vertebrates, is an admirable example—the leg of a horse, the arm of a man, the wing of a bird, the anterior support of the wing of a bat, and the fin of a fish being different forms of the same part, in one case one portion, in another case a different one, being largely developed to meet the wants of the creature; but almost any other part may be taken, although perhaps the result may not be quite so striking. For instance, the mouths of insects, the same parts exist in almost all: the mandibles, the maxillæ, the mentum and lingua, the labial, and maxillary palpi being present in almost all; but often so profoundly modified that it is difficult at first to recognize that they really are the same parts, so wonderful are the adaptations to the requirements of the insect. What plausible explanation except community of descent can be given for this? If it did not arise from this cause why should not the sucking mouth of a butterfly or a gnat be formed of totally different parts from those in the mouth of a wood-eating beetle? Nature does not always utilize the same part for attaining even a similar purpose in allied creatures; thus, for instance, in insects and *Acari* parasitic on hairy creatures, the apparatus for holding the hair varies greatly; in the *Pediculus capitis* of man the front leg is furnished with a great falx doubling back like the blade of a clasp-knife. In the *Disparipes* and the *Trichodactalus* of the humble-bee the same leg has an immense hooked claw, and in the *Myobia* of the mouse a strange curved lamina folding round a chitinous peg, and holding the hair between the two; but, on the other hand, in the closely allied *Listrophorus* of the mouse it is not the claw, but the greatly-enlarged maxillary lip, which becomes a flexible chitinous organ, to wrap round and hold the hair; and in

the Hypopial Nymph of the *Dermacarus* of the squirrel, and of the closely-allied form found on the mole, chitinous labia for the same purpose are developed round a concave furrow at the extreme hinder-end of the ventral surface.

After this most important of all arguments on the subject I may refer to other points which, if they have not the far-extended range, are possibly more striking to many minds; such a feature is the existence of rudimentary organs in some species or forms which are useless and functionless in them, but are effective in allied creatures. Thus the eyes of *Spalax* and *Chrysochloris* among Mammals, and of *Myxine* amongst fishes, are hidden beneath the skin and incapable of receiving luminous impressions, and in the young of *Petromyzon* they are actually covered by muscles. Again, the whales have a rudimentary pelvis and hind limbs hidden beneath the skin, and among snakes the boa-constrictor has rudimentary hind limbs quite unserviceable. In snakes generally one lobe of the lungs is rudimentary. In *Apteryx* the minute wing is hidden by the long hair-like body feathers. The *Chalcididæ* and allied families are very interesting in this respect, as even in the British species we may find almost every stage, from the possession of four powerful wings hooked together in pairs, as in most other *Hymenoptera*, to an entirely apterous creature. In some all four wings are reduced in size, and this is found in endless grades in different species. In *Mymar* the hind-wing is abortive except the costal nervure, which is shortened, but persists and is attached to the slender fore-wing by a single hook, forming a supporting piece; while in other forms only the nervure exists in all four wings; and lastly we find forms where even this is absent. Again, the reproductive organs are instructive. It is difficult, except by descent, to account for the functionless mammæ of the male in man, or for the so-called uterus masculinus, really the homologue of the Mullerian ducts (or oviducts), of the female; while, on the other hand, in rodents, moles, and lemurs, the clitoris is actually perforated by the urethra, a singular confirmation of the received view as to the morphology of this organ. Probably, however, one of the best instances is the late discovery of a third central eye, useless and hidden beneath the skin, in some lizards; and the connection of this eye with the so-called pineal gland found in mammals, and even in man himself, which is a small projection of the brain the use or origin of which has puzzled anatomists to no small

extent. It is a highly interesting fact that rudimentary organs are almost always larger in the embryo than in the adult. This brings me to another great argument in favour of evolution, viz., the disclosures of embryology, which have led to the enunciation by Fritz Muller and Hæckel of the law that "the ontogeny comprises the phylogeny," or in more ordinary language, that the development of an individual is a sort of record of the development of the species to which it belongs. This explains numerous cases which are incomprehensible, except on the supposition of a common descent, and appeals strongly to the mind. It has always seemed to me that the most remarkable instance is the well-known one, that the Nudibranch Mollusca, which have not any shell when adult, yet possess a well-developed shell like a periwinkle when in their embryo condition, although they are then within a membrane and the shell is useless to them. There are, however, hundreds of other instances. Thus the embryo grubs of *Muscidæ* (*Diptera*) possess a head with antennæ and jaws, although these organs are absent in the hatched larvæ. In the embryo larvæ of *Sphinx* there are ten pairs of abdominal legs, five pairs of which disappear before hatching. The grubs of bees in the embryo condition have a head like other *Hymenoptera*, and three pairs of legs, but they similarly disappear. The larva of *Chærocampa porcellus* is remarkable among those of *Sphingidæ* for the absence of the dorsal horn, but it exists in the very young specimens, but does not grow or persist. The *Acarina* are specially distinguished by the unsegmented abdomen, but it is segmented in many of the young larvæ. The young of the tapir and wild-hog are striped, while the adults are plain (other allied forms being striped), and the whelps of the lion and the puma are often more or less striped like so many other cats. The whale-bone whale has teeth in the fœtal, but not in the adult condition, and the teeth in the front part of the jaw of the calf and some other ruminating quadrupeds never cut the gum. The young blackbird is spotted something like the thrush; so are the young of the common (white) gull. The tadpole of the common salamander has gills, and lives in water; *Salamandra atra* lives high up in the mountains, and brings forth its young fully-formed. This animal never lives in water in any stage, but if a gravid female be opened tadpoles with beautifully feathered gills will be found, which can swim when placed in water; and there are hundreds of other cases. I will just mention the singular life-history

given by Fabre of the larvæ of the *Sitaris* beetle, which he says is first batched in the nests of some bees as a minute, active creature with six legs, long antennæ, and four eyes. The male bees emerge before the females, and the *Sitaris* larvæ jump on to them, crawl on to the female while pairing, and when that sex deposits its eggs on the honey the larvæ spring on the eggs, devour them, then the larvæ undergo a change, the eyes disappear, the legs and antennæ become rudimentary, they feed on honey, and resemble other beetle larvæ.

It must not, however, possibly be supposed that the development of the individual is an *exact* record of that of the species. Weismann is of opinion that if a character is strongly beneficial to the adult, it has a tendency to be developed earlier in the life-history as time goes on, and it is difficult to believe that changes which profoundly affect the adult do not to some extent affect the embryonic and immature stages.

Evolution has to consider not only the physical, but also the mental qualities, and this raises the vexed question of instinct and reason; what is the difference if they be different? We must first reject mere reflex action, such as laughter when a person is tickled. Romanes gives the following definitions :—"Reflex action is non-mental neuro-muscular adjustment due to the inherited mechanism of the nervous system, which is formed to respond to particular, and often recurring stimuli by giving rise to particular movements of an adaptive, though not of an intentional kind. Instinct is reflex action into which there is imported an element of consciousness. The term comprises all those faculties of mind which are concerned in conscious and adaptive action antecedent to individual experience, without necessary knowledge of the relation between means employed and ends attained, but similarly performed under similar and frequently recurring circumstances by all individuals of the same species. Reason is concerned in the intentional adaptation of means to ends, and may be exercised in adaptation to circumstances novel alike to the experience of the individual and that of the species." I should be inclined to put it in homely language that instinct is the quality which prompts creatures to perform actions consciously, but without experience, learning, or thought, so that they perform them without teaching or consideration; and that reason is that which enables them to learn, either from their own experience or teaching, or to exercise thought

either in adapting means to ends or otherwise. But if we adopt any such definition is it possible for an unprejudiced observer to keep a pet dog or cat without seeing by its everyday actions that it reasons, that it learns by experience how to get what it wants, and even its owner's habits; and that it can be taught, sometimes more, sometimes less, but always something. Putting aside all wonderful stories it is the constant little ways, generally characteristic of the individual, which impress me most. When I was a boy I had a Skye terrier, which slept in the kitchen but as soon as the servants opened the door ran upstairs and jumped on to my bed. Two bells were rung—one when it was time to get up, the other for breakfast: at the first the dog never stirred, although I got up, but at the second the dog instantly jumped off the bed and left me no peace until I let it out to go down to breakfast. This surely was not inherited instinct. Space will not allow me to multiply instances. It may be said that these are animals altered by generations of association with man; this only amounts to saying that they have learnt, which seems to me to be the essence of the whole thing; but let us look at wild creatures even low in the scale. Oysters taken from deep water, if left dry, soon open their shells, lose the water within, and perish; but if placed in shallow tanks and occasionally left uncovered by water for a short time they learn to keep their shells shut, and live longer. This is turned to great practical account, the oysters brought to the Paris market from long distances being thus educated in oyster schools. The razor shells dislike salt; if it be sprinkled above their burrows they come to the surface and quit them, but if once seized when they do so, and allowed to escape, no amount of salt will bring them to the surface again (Bingley). Sir John Lubbock found that both ants and bees could be taught their way to honey, &c., by repeated journeys, but that if it were complicated they most of them lost their way the first few journeys, but afterwards went correctly and with apparent confidence. Förel found that young ants do not know enemies (strange ants), but that as they grow up they immediately attack an intruder. Lubbock found that bees know the hive by its position, and fly to the place where it had stood if it be removed in their absence. The mason-bee, according to Blanchard, does not make a nest of its own if it can possess itself of one belonging to a neighbour, it sometimes even utilizes an empty snail-shell. A wasp, if it finds a piece

of paper, often uses it instead of making the paper for itself out of wood. Mr. S. S. Saunders took the nest of a trap-door spider with the occupant at home and placed it upside-down in a flower-pot. In ten days the spider had made a new door at what was formerly the bottom, but was now the top. Gulls and crows carry shell-fish to a height and drop them upon rocks to crack them. The house-martin has manifestly changed its habits, and the American house-swallow has effected this change within the last three hundred years. Mr. L. H. Morgan found that the beaver widens the openings in its dam when there is a flood and narrows them in drought. The elephant has been seen to blow an object which is on the ground beyond its reach against the opposite wall that the rebound may bring it nearer. I think that the Zoological Gardens is an excellent place to consider this subject, because the creatures there are wild animals which have had to adapt themselves to altered circumstances; they are not accustomed in nature to look on man as an organism instituted for the purpose of providing them with buns and sugar, but the most cursory observer will soon see how thoroughly most of them have learnt the lesson. One day I gave a large piece of biscuit to a Falkland Island goose; it tried to get it down, turning it different ways, but could not do so; it then took the biscuit in its bill and threw it violently against the stones several times, but it did not break; finally it took the piece in its bill and held it in the water till it was soft, when it quickly disposed of it. I stuck a large bit of sugar between the wires of the cage of the hybrid paradoxure, a creature which has a quaint habit of rolling up its long tail in a flat spiral. It passed its long claws through the wires so as to clasp outside the sugar, and had a good pull, but the desired morsel would not come through; then it tried its teeth and bit off the piece inside; then it licked what remained, and finally retired in disgust, and sat still at the other end of the cage. I now pushed the sugar further through with the handle of my umbrella; the paradoxure instantly saw the change, jumped at the sugar, and pulled it through with its claws. You may see these things and many others with numbers of the creatures any day. There is a little bear that will walk up the perpendicular bars and turn a circle upon them for a lump of sugar. There is an old crow that pipes "The miller's wife." There are the ridiculously human Barbary apes, and finally there is Sally, the bald chimpanzee, the most

amusing and intelligent beast I ever saw. She will poke a straw through the keyhole or a small gimlet-hole in the boards when told. She will put a straw as a flower in the keeper's button-hole, or brush his coat when told. She will keep pence in a hole and drop them into the keeper's pocket to pay for beef-tea, which she will drink with a spoon, returning the spoon through any indicated division of the network, and numberless other tricks, and she is constantly acquiring new ones. On the 7th of February last I was there, and she had her arm out of the cage, with the back of the hand upward. A solitary fly, which had survived in the warm house, alighted upon it, which Sally evidently wished to capture. She fixed her eyes on it and drew in her hand and arm very slowly and gently, and without moving any other part of her body. She got it nearly in, but as the hand passed through the wire netting it touched, and the fly was frightened and flew; instantly, quick as lightning, Sally darted out the other hand and made a grab at it. She did not catch it, but could anything be more human or more evidently reasoned? The conclusion which I draw from all this is, that whether instinct and reason be separate things or not, or whether instinct be only reason grown habitual and inherited, yet that in either case the nature of the mind of the lower animals is the same as that of man; and that it is a question of degree and not of kind; man and animals may each have both instinct and reason. The mind of the lowest savage is probably far above that of Sally, but it seems to me to be only a higher development of the same thing.

All this may prove evolution to be true, but it does not prove that Darwin's is the correct explanation of it; but survival of the fittest and sexual selection are so familiar to you, and in some form or other are so continually before you, that I do not propose to repeat this theory, nor the numerous facts in support of it, but rather to utilize the little time remaining to me in considering a few of the points, and the objections and limits to these laws if any. And firstly let me call your attention to the fact that Darwin never asserted that these laws explained everything, and his principal opponents, such as St. George Mivart, did not deny that they had some operation; but whereas Darwin assigned them the principal place, Mivart allowed them only a small influence. Darwin in his later writings was rather inclined to limit than to extend these laws. With regard to the existence of the tendency to

vary requisite to support Darwin's theory, we are apt to forget how great this is. We hardly ever saw two human faces exactly alike, and the same is doubtless true of animals if observed equally closely. Everyone knows his own dog, and a skilled shepherd knows each sheep. The two sides of the body usually vary greatly, so that a man with the two rms the same length and the two legs similarly corresponding is very rare, and although we are actually all artificially taught to write the same way, we all write different hands. Now what are the main objections? Firstly, to my mind, both to evolution and the explanation, stands the sterility of hybrids. It is extremely difficult to answer this, but we may observe, firstly, that it is only in the case of the Vertebrata and some plants that we really know whether they are fertile or not; as to other groups, we are ignorant on the subject. Secondly, we are apt to argue in a circle; we are inclined to take the fertility or sterility of hybrids as a test of species, and then to cite our classification to prove that hybrids between different species are sterile. Moreover the laws of sterility and the reverse contain many things we do not understand. The Mexican *Axolotl* has been proved to be an immature form of *Amblystoma*, but it is sexually fertile in the *Axolotl* stage, and *Amblystoma* bred from *Axolotl* is almost, but not quite sterile, while other *Amblystoma* are freely fertile. Then there is reason to suppose that a hybrid can to some extent fertilize one of the original species, although the embryo does not usually reach maturity. Another objection, to the explanation only, is the existence of neuter insects. It is very difficult to see how these can have been produced by natural selection, as they cannot ever have reproduced their kind. This difficulty appears to have been so strongly present to Darwin's mind that it almost shook his faith in his own theory; he succeeded finally in satisfying his own mind, but perhaps he was not as happy in explaining this to his readers as he was in most other cases. There is the difficulty why similar forms were not produced in greater numbers by the same conditions. The oft-quoted neck of the giraffe is a good example; there are not more vertebræ in it than in shorter necks, and Darwin reasonably says that it must have been an advantage to a creature inhabiting a country liable to drought to be able to browse on the leaves of trees when grass failed, and that therefore a long neck must have been an advantage, and have been liable to be increased; but it is replied that there were

plenty of other Ungulates in the same place at the same time; why did not they acquire long necks also? It may be noted that there almost seems to be something special in the nature of the giraffe, as it is the only mammal which has horns when it is born. Another objection is the imperfection of the geological record, and the absence of intermediate forms. The answer to this seems to me to be that the geological record is less imperfect than might reasonably have been expected; and that intermediate forms do exist, or have existed and left traces, in greater numbers than we had a right to anticipate. *Amphioxus* is a celebrated instance. The wing of the young ostrich is covered by curious scale-like plumes, and has three phalanges to the principal finger instead of the two possessed by most other birds, thereby approaching reptiles. The cerebellum in *Aplacentia* resembles birds in the disproportionate development of the median lobe, and this is coexistent with other important bird-like characters; as, for instance, the oviparus reproduction and meroblastic ovum of *Echidna* and *Ornithorhynchus*, their possession of a cloaca and of jaws elongated to form a beak. The double uterus of the *Marsupialia*, &c.; the fossil *Odontormœ*, &c., or toothed birds; and the well-known *Archœopteryx*, are intermediate forms, and instances might be multiplied to a great extent did space permit. Everyone who has attempted any kind of zoological or botanical classification knows how he has been puzzled by intermediate forms; but every fresh form found is taken as a fresh basis, and forms are asked for intermediate between that and the nearest known; so that until the whole chain is completely found, which is not likely ever to be the case, there must still be a demand for missing links. Again, it is said that there is not always that steady progress in the geological record from the simple to the complex which might have been expected; as, for instance, Scudder found an insect as early as the Devonian furnished with the stridulating apparatus of male locustidæ; and the highest form of the *Molusca*, the *Cephalopoda*, were more numerous in later geological periods than they are now. On the other hand, fishes on the whole increase in complexity from the first to the last geological period, and this is probably the case with the average of other groups; but there does not seem to be any reason why creatures should not revert to a simpler condition if the surroundings rendered it advantageous to them to do so, without that fact telling against the survival of the fittest.

A very able article appeared in the "North British Review" for June, 1867, showing how immense were the chances against the survival of a variation occurring in one individual only. This article so impressed Darwin himself that in the later editions of his works, and in "The Descent of Man," he stated that he had become convinced that for a variation to survive it must arise in several individuals at one time; but he thought this not unlikely to occur. The chances are undoubtedly enormously against the survival of the variation occurring in one individual only; but then probably only one variation out of an enormous number does survive. And it also seems to me that the variations need not follow a direct line; two individuals might vary somewhat in the same direction, although not similarly. The offspring of these two might be an intermediate form, and this again pairing with a more extreme variety might produce again an intermediate variety; thus there might be soon a number of specimens all more or less varying in the same direction, and the ultimate outcrop might be considerably different from the first direction of variation. This would greatly diminish the adverse chances, for exterior surroundings might well cause several to vary in the same place more or less in one direction. The result of pairing cannot always be foreseen; if two top-knotted canaries be paired, the offspring is generally bald, but undoubtedly a variety arising in several individuals at once in the same place would be much more likely to survive. Then there is a difficulty how the small beginnings of organs could be useful. The before-mentioned eye-spots on *Deilephela* larvæ and the mammary glands are examples of this, and it is a serious difficulty, as although many things would be useful in their first stage there would seem to be plenty of others that would be useless. Again, an allied difficulty is the occurrence of things the utility of which is not apparent. Certain butterflies have a band of colour with a row of white spots on the band; in some localities the spots at the top of the row are the larger, in other places those at the bottom are so, yet the varieties although local are constant. The specimens of *Lycena agestis* found on Arthur's Seat, Edinboro', had a minute white spot on the upper wing not found on any other specimens; the variety was called Artaxerxes, but bred freely with the ordinary type. The specimens of *Vanessa antiopa* found on the Continent have a yellow border; the English specimens have it straw-coloured. The difference between the females of *L. agestis* and

L. *alexis* is chiefly in the position of certain inconspicuous black spots on the under-wing. The butterfly *Anosia plexipus*, which is spreading over the world with such marvellous rapidity, has two forms, a northern and a southern ; the difference is only in whether some small spots on the upper-wing are nearly white or light-brown. It is the northern form that is spreading. It is difficult to see how utility can have dictated these things, or the brilliant colours on the inside of many bivalve shells, or the elegant shapes of many asexual radiolarians, or the abortion of the index finger in the Potto *(Perodicticus)*, one of the Lemurs. Possibly the direct action of external circumstances, as opposed to their indirect action through natural selection, may have more influence than we are at present inclined to allow. Coster states that young oysters taken from the English shores and placed in the Mediterranean at once altered their style of growth, and developed diverging rays like the Mediterranean species. Pony breeds have arisen quite separately in different parts of the world. Great changes take place in the plumage of parrots when fed on certain fish. The black shouldered Javan peacock, *Pavo nigripennis* is considered quite a separate species, and yet similar birds were bred suddenly in a flock of the ordinary peacock in England without any known reason. The peculiar Porto-santo rabbit reverted in England to the common form in four years. The white-silk fowl reverted to the ordinary fowl in England in spite of great care. It cannot, I think, be held to detract from the value and importance of the theory of natural selection, if we have to admit that it is not the one only cause of variation. Amongst other probable causes may be mentioned the inherited effect of use lately advocated by Mr Herbert Spencer, viz., that an organ constantly exercised in a particular manner may become abnormally developed in a particular direction, and that such development, although to a certain extent artificial, might be inherited by the offspring. Again there is the "physiological selection" suggested by Dr. Romanes, which is that the variation might occur first in the sexual organs causing partial sterility with the parent form, while individuals of the variety were perfectly fertile *inter se*. This would of course require that the variation should occur in more than one individual, in which case it might mark off a race which might afterwards vary in other respects. May we not probably, as far as our present knowledge goes, reasonably come to the following conclusions?

1. That evolution is one of the great leading facts of nature and is fairly well established.

2. That survival of the fittest and sexual selection have probably been the principal agents in effecting evolution of species.

3. That the direct action of external circumstances has probably had considerable influence, that the other causes suggested may have assisted, and that almost pure chance may possibly have had some trifling influence.

4. That it is not improbable that there are other causes which we have not yet traced which have contributed to the result.

5. That we have not any reason whatever to suppose that life has arisen out of non-living matter by evolution.

On a Fossil Marine Diatomaceous Deposit from Oamaru, Otago, New Zealand.

By E. Grove and G. Sturt, F.F.R.M.S.

Part III.

Plates V. and VI.

(*Taken as read March 25th, 1887.*)

Trinacria ventricosa, n. sp., Gr. and St.—In this species we have two dissimilar frustules alternating with each other. The primary valve, as it may be called, has slightly concave sides with a clear margin. The centre is moderately inflated with a small circular umbilicus, usually surrounded by a ring of pear-shaped cellules, the remainder of the surface being covered with large, irregularly radiating granules. Processes straight, elongated, like those of *Trin. regina*, Heib., to which this valve bears a general resemblance.

The secondary valve has a large inflated centre, leaving at each corner a flat triangular space, on which is the indication only of a nodule. Surface dotted with papillæ, presenting at the margin a rugose appearance.

Length of sides of valves usually about ·005″. From several specimens observed in contact, it appears that these two forms belong to the same filament, and that the pseudo-nodules of the secondary valves meet and are continuous with the processes of the primary valves, also that the inflations meet one another, touching at their apices. Frequent.

Pl. V., Fig. 1, primary valve; Fig. 2, secondary ditto; Fig. 3, frustular view.

T. ligulata (Grev.), Gr. and St. (*Triceratium ligulatum*, Grev., "T. M. S.," Vol. xii. p. 91, Pl. 13, Fig. 9).—Corresponds with Greville's figure, which is clearly a Trinacria. It is probably only a small variety of *T. excavata*, Heib. Length of side, ·003″. Frequent.

T. pileolus, var. *jutlandica*, Grun.—A small form agreeing with Grunow's description and figure ("F. J. L.," p. 16, Pl. B, Fig. 56), excepting in the presence of a central spine. Rare.

ACTINOPTYCHEÆ.

Actinoptychus splendens (Shadbolt), Ralfs. (in "Prit.," p. 840).—Differs in no respect from recent examples. Not frequent.

A. (*splendens* var. ?) *glabratus*, Grun. ("Van Heurck Synop.," Pl. 120, Figs. 6-9).—Through the kindness of L. Hardman, Esq., we have seen one specimen corresponding very nearly to the figure of var. *incisa* (*l.c.*, Fig. 9.)

A. vulgaris Schum., var. *maculata*, n. var., Gr. and St.—This variety comes nearest to var. *australis*, Grun. ("Van Heurck Synop.," Pl. 121, Fig. 8), but differs in the size and arrangement of the apparent spots, especially in the symmetrical group in each compartment containing the process. The group of enlarged cells in the striated margin, opposite to each process, is also a remarkable feature. Diam. about ·005″. Not uncommon. (Pl. V., Fig. 5.)

A. nitidus, Grun., (*Heliopelta nitida* Grev., "T. M. S.," Vol. xiv, p. 5, Pl. 11, Fig. 18).—A small form, resembling the above in the character of its cellulation, is abundant.

A. Wittii, Janisch. (A. Sch., "Atl.," Pl. 100, Fig. 12).—Not very rare, ·004″ to ·006″ in diam., with finer markings than those in Schmidt's figure.

Actinodiscus barbadensis, Grev. ("T. M. S.," Vol. xi, p. 69, Pl. 4, Fig. 11).—Not very rare. Identical with Greville's form.

Craspedoporus elegans, n. sp., Gr. and St.—This beautiful diatom has all the characteristics of Greville's Genus ("T. M. S.," Vol. xi, p. 68, Pl. 4, Figs. 9 and 10), but differs from both the species described by him. Valve convex, flattened at centre, with from 7 to 10 large, transversely oval ocelli, each of which is bisected vertically by a narrow septum or bar. The ocelli are situated at the outer ends of pear-shaped clear spaces, which are much shorter than in Greville's figure of *C. ralfsii*. General surface granulate, the granules somewhat indistinct in the centre but arranged in lines between the ocelli and ceasing near the margin, where there is a clear annular space. Diam. to ·0035″. Not very rare. (Pl. V., Fig. 6.)

The occurrence in this deposit of the genera *Craspedoporus*, *Actinodiscus*, *Porodiscus*, and other species, hitherto observed only in the deposit from Cambridge Estate Barbadoes is an important fact in relation to the distribution of the Marine Diatomaceæ during the Tertiary period.

Anthodiscus, n. gen., Gr. and St.—Characteristics: Valves discoid, divided into numerous compartments by depressed, radial, clear spaces extending from the margin, but not reaching the centre. Differs from *Cosmiodiscus* in the fact that the radial divisions are not merely clear superficial spaces, formed by the absence of cellules or granules; but are actual divisions of the nature of internal septa.

A. floreatus, n. sp., Gr. and St.—Valve circular, ·0028″ to ·003″ in diam., with numerous marginal compartments (14 to 21 have been observed), resembling the petals of a flower. The compartments are granular, slightly elevated at the margin, and extend inwards for a length of about one-third of the radius.

In the outer edge of each compartment is a depression or notch, giving a crenulated appearance to the circumference of the disc. The central portion of the disc, which is flat, has a clear umbilicus, round which is a zone of granules divided irregularly by clear rays.

At the outside of the granular zone is a slightly depressed annular clear space, from which spring the granulose compartments or florets.

In frustular view this form is cylindrical, with flat top, and corrugated or crenulated exterior. (Pl. VI., Fig 20.)

Cosmiodiscus Normanianus, Grev. (" T. M. S.," Vol. xiv, p. 80, Pl. 8, Fig. 11).—We do not at present remove this form from the Genus in which Greville has placed it; though in the character of the radial clear spaces, it differs materially from the other two species described and figured in the same place. Eventually it may have to be placed in the last Genus (*Anthodiscus*), or in one of its own. It is not of very rare occurrence, though usually small. We figure the finest specimen which has occurred to us, and for which we are indebted to Lawrence Hardman, Esq. Diam., ·0022″. Number of compartments, 17. (Pl. VI., Fig. 21.)

It will be seen that at the marginal end of each of the clear radial dividing spaces, there is a single detached punctum not

shown in Greville's figure. We much regret that, after a long search, we have been unable to find the only authentic specimen recorded in his slides, now deposited in the British Museum.

Asterolampreæ.

Asterolampra marylandica Ehr. (Grev. "T. M. S.," Vol. viii, p. 108, Pl. 3, Fig. 164).—Rare.

A. decora, Grev. ("T. M. S.," Vol. x, p. 43, Pl. 7, Fig. 6). —Frequent.

A. vulgaris, Grev. (*l.c.*, Fig. 19). Abundant.

Arachnoidisceæ.

Arachnoidiscus Ehrenbergii, Bail. ("Atl.," Pl. 73, Fig. 1).—Typical, and agreeing with recent examples from California. Diam. very variable, from ·0022″ to 01″. Not unfrequent.

A. (Ehrenbergii var.?) indicus E. (*l.c.*, Pl. 58, Fig. 6).—Rare.

Stictodiscus Hardmanianus, Grev., var. *megapora*, Gr. and St.—Rather smaller than the type, and differing in the large size of the clathrate cellules, surrounding the central ring of small granules. This ring is occasionally obsolete. Diam. to ·0045″. Frequent. This form seems closely allied to *Arachnoidiscus*.

S. californicus, Grev. var. *areolata*, Grun. ("Atl.," Pl. 74, Fig. 1).—Diam. to ·0075″.—Not scarce.

S. californicus, var. *nitida*, Gr. and St.—A small form from ·002″ to ·0035″ in diam., dotted over with large shining granules. Margin resembling the type-form, with short broad lines of plication, and, in perfect specimens, a coarsely striated rim. Frequent. (Pl. V., Fig. 7.)

Melosireæ.

Paralia sulcata (Ehr.), Cleve (*Orthosisa marina*, "S. B. D.," Vol. ii, p. 59, Pl. 53, Fig. 338).—Very frequent.

Melosira sol. (Ehr.), Kütz. ("Van Heurck Syn.," Pl. 91, Figs. 7, 8, and 9).—Frequent.

M. clavigera, Grun. (*l.c.*, Figs. 1 and 2).—Frequent.

M. borreri, W. S. ("Van Heurck Syn.," Pl. 85, Figs. 5, 6, and 7).—A small disc about ·002″ in diam. with thick walls and convex surface strewn with small scattered granules. Rare. We place this here with some hesitation.

M. Westii, W. S. ("S. B. D.," Vol. ii, p. 59, Pl. 52, Fig. 333).—Frequent.

Porodiscus interruptus, n. sp., Gr. and St.—Valve circular, very convex, with clear central space about one-third of the diameter of the disc. The rest of the surface covered with radiating lines of distinct granules, interrupted near the margin by a clear annular space, between which and the rim is a narrow belt of closely-set granules. Margin clear. Diam. to ·005″. Rare. Pl. V., Fig. 8 (a small example.)

Brightwellia pulchra, Grun. ("Van Heurck Syn.," Pl. 128, Fig. 9).—Abundant, and very variable in size. Specimens observed from ·0025″ to ·0075″ in diam.

Podosira hormoides (Mont.), Grun. ("Kasp. Meere Diat.," p. 33).—A large coarse form which, but for the absence of the large puncta, might be classed as *P. stellulifera*, Grun. Diam. to ·005″. Not unfrequent.

P. maxima, Kütz. (*Hyalodiscus*, Grun., "K. M. Diat.," p. 33). —Similar in general aspect to the type-form, but without the usual traces of an opaque umbilicus. Diam. about ·007″. Not rare.

This form comes very near to *Coscinodiscus*.

Hyalodiscus subtilis, Bail. ("Prit.," p. 815, Pl. 5, Fig. 60).—Varies greatly in size and in the proportionate diameter of the umbilicus. Forms occur from ·002″ in diam. with a large umbilicus resembling *H. scoticus* (Kütz.), Grun., to ·015″ in diam., with an umbilicus of ·0084″. The whole surface is covered with lines of granules about 35 in ·001″. These large, coarsely marked forms may be classed as var. *robusta*.

H. radiatus (O'Meara), Grun. (Cl. and Gr., "Arc. Diat.," p. 117, also "F. J. L.," p. 41).—Smaller, and not so coarsely marked as typical forms frōm Kerguelens Land. Not rare.

H. arcticus, Grun. ("F. J. L.," p. 41, Pl. E., Fig. 37).—Frequent.

Coscinodiscus radiatus, Ehr. (Grun., "F. J. L.," p. 19, and 20, Pl. C., Fig. 1, *et seq.*)—Frequent, with much variation. The typical form is present, as well as vars. *major* and *minor*, but the most numerous variety is *C. argus* (*l.c.*, p. 20, and "Atl.," Pl. 61, Fig. 2), which passes into *C. heteroporus* ("Atl.," Pl. 61, Fig. 4) on one hand, and back to *C. radiatus* on the other.

C. marginatus, Ehr. (Grun., *l.c.*, also "Atl.," Pl. 65, Fig. 3). —From ·003″ to ·0045″ in diam., with thick-walled cellules about 6 in ·001″.

C. oculus-iridis, Ehr. (Grun., *l.c.*, pp. 24 and 25).—Diam. observed to ·012″. Cellules at centre about 7 and near the margin 6 in ·001″. This is rather coarser than the type-form, and is nearer to var. *borealis* (Bail.), Grun. (*l.c.*, p. 25). Scarce.

C. bulliens, A. Sch. ("Atl.," Pl. 61, Fig. 11, also "F. J. L.," p. 20).—Small, about ·0025″ diam. Frequent.

C. radiosus, Grun. ("F. J. L.," p. 20, also "Van Heurck Syn.," Pl. 132, Fig. 7).—Moderately convex, diam. about ·0035″, no umbilicus, cellules radiant, about 15 in ·001″.—Scarce. We put this here with some hesitation.

C. oamaruensis, n. sp., Gr. and St. Frequent, but usually in fragments. Large, convex, with small clear umbilicus, surrounded by a ring of cellules. Cellules hexagonal, radial, about 12 in ·001″ at the centre, 15 at the margin, close within which is a ring of puncta about ·0004″ apart. At the ends of the intercalated lines of cellules are minute puncta, which under a low power give the disc a somewhat scabrous appearance, especially towards the centre. Diam. observed up to ·011″.

This form approaches *C. concinnus*, but differs in the much coarser cellulation, which is not punctate, and in the clear umbilicus.

C. inæqualis, n. sp., Gr. and St.—Small, flat, ·0025″ to ·003″ in diam. Cellules hexagonal, radiant, with a slight tendency to a fasciculate arrangement, starting from a point not in the centre of the disc, increasing slightly in size, from 12 at the centre to 10 in ·001″ at a point about two-thirds of the radial length from the centre, whence they decrease slightly towards the margin, where a distinct ring of very small cellules occurs. Centre furnished with a few rough excrescences, and usually with a conspicuous sub-central tubercle.

This species resembles the form figured by Schmidt ("Atl.," Pl. 57, Fig. 44), but is without the marginal puncta there shown.

C. decrescens, Grun. ("F. J. L.," p. 28, Pl. C., Fig. 18).—Small, about ·0027″ in diam., resembling Grunow's var. *repleta*. Scarce.

C. subtilis, Ehr. (Grun., *l.c.*, p. 29, Pl. C., Fig. 26).—Not common.

C. subtilis, var. *symbolophora*, Grun. (*l.c.*, p. 30, Pl. D., Figs. 3-6).—Up to ·005″ in diam. Has usually a star of four rays in the centre. In other respects exactly as *C. subtilis*. Common.

C. Rothii, Grun. (*l.c.*, Pl. 100, Figs. 20, 22).—Scarce and smaller than the type.

C. angulatus, Grev. ("T. M. S.," Vol. xii., p. 9, Pl. 2, Fig. 11). —Corresponding closely with Greville's description and figure, ·0025″ to ·003″ in diam., usually with eight, but occasionally with 10, and even 12 small marginal processes. Very common.

C. Kutzingii, A. Sch. (Grun., "F. J. L.," p. 32, Pl. D, Fig. 18).—Diam. ·0025″ to ·003″. Scarce.

C. curvatulus, Grun. (*l.c.*, pp. 30, 31).—A small variety present, but scarce.

C. eccentricus, Ehr. (A. Sch., "Atl.," Pl. 58, Figs. 48, 49). —Not scarce, small.

C. minor, Ehr. (*l.c.*, Pl. 58, Fig. 39).—We class as this a small form about ·001″ diam., with cellules arranged somewhat as in *C. eccentricus*. Not unfrequent in the lighter part.

C. concavus, Greg., nec. Ehr. ("G. D. C.," p. 28, Pl. 2, Fig. 47). —This form appears to us to be identical with recent specimens of Gregory's species from the Orkney Islands. Diam. to ·0075″. Cellules punctate, six in ·001″. This appears to be the same as Greville's *C. pulchellus* ("T. M. S.," Vol. xiv, p. 3, Pl. 1, Fig. 7), found in the Barbadoes deposit. W. Smith's *Melosira, cribrosa* ("Ann. Nat. Hist.," Jan., 1857, p. 13, Pl. 2, Fig. 15), may possibly be a smaller form of the same. Frequent.

C. elegans, Grev. ("T. M. S.," Vol. xiv, p. 3, Pl. 1, Fig. 6).—Type form, very rare.

C. elegans, Grev. var. *spinifera*, Gr. and St.—Valve with central conical elevation rising from a circular depression. Centre filled with crowded fine granules, from which to the margin radiate lines of larger granules, the spaces between which at the outside are filled up by short lines, leaving distinct subulate clear spaces between the marginal and central portions. On the margin, which is striate, are from 20 to 30 small processes. Frequent. Diam., to ·0035″. This form is akin to *Cestodiscus*. (Pl. V., Fig. 9.)

C. nitidus, Greg. ("G. D. C.," p. 27, Pl. 2, Fig. 45).—Scarce.

C. scintillans, Grev. ("Q.J.M.S.," Vol. xi, p. 230, Pl. 9, Fig. 6).—Rare.

C. griseus, Grev., var. *Galopagensis*, Grun. ("Van. Heurck Syn.," Pl. 128, Fig. 7, and Pl. 132, Fig. 1).—Diam. about ·0075″. Scarce. A smaller form, which seems to be typical, occurs rarely.

Striated fragments occur occasionally in this deposit, which may be fragments of the discs or connecting membranes of large forms of *Coscinodiscus*, but at present we are without certain evidence of this.

Stephanopyxis turris (Grev.), Grun. (*Creswellia*, Grev., "G. D. C.," p. 64, Pl. 6, Fig. 109; also "F. J. L.," p. 36).—Not frequent, but typical.

St. turris, var. *brevispina*, Grun. ("F. J. L.," p. 35).—Frequent, usual diam. about ·0016″. Length about ·0012″, with about 10 cellules in ·001″. Central group of spines very small and short.

St. (turris, var. ?) *valida*, Grun. ("F. J. L.," p. 37).—Very common. The most abundant diatom in the deposit. Agrees with Grunow's description, but exceeds the maximum diam. named by him. Valve moderately convex. Diam. from ·0025″ to ·006″. Cellules about 3 in ·001″. Spines usually conspicuous, curved, and with sharp points, in sub-marginal ring of 10 to 20 in number. In some of the larger specimens the spines are small or even wholly wanting, as is the case also in the closely-allied *St. superba* (Grev.), Grun. (*Creswellia*, Grev., "T. M. S.," Vol. ix, Pl. 8, Figs. 3, 5). Such large specimens without spines seem to us to be identical with *Coscinodiscus splendidus*, Grev. ("T. M. S.," Vol. xiii, p. 44, Pl. 5, Fig. 3).

St. ferox (Grev.), Grun. (*Creswellia*, Grev., "Q. J. M. S.," Vol. vii, p. 166, Pl. 8, Figs. 15, 16).—A form agreeing with this is present sparingly; but as a frustular view shows two dissimilar valves, one of which resembles in all respects those figured by Greville, while the other is much less convex, we cannot consider it as typical.

St. barbadensis (Grev.), Grun. (*Creswellia*, Grev., "T. M. S.," Vol. xiii, p. 3, Pl. 1, Fig. 11).—We place here a species which is very abundant in this deposit. Frustular views show a pair of dissimilar valves with broad sutural keels. One valve closely resembles Greville's figure, but the other is less convex, and has numerous spines, which are not curved, and are slightly widened at the ends. The whole frustule bears a resemblance to *St. corona*, Ehr. ("Van Heurck Syn.," Pl. 83 ter., Fig. 11), and we agree with Herr Grunow ("F. J. L.," p. 39) that it is probably a form of that species. Valves ·0012″ to ·0022″ diam. One hemispherical, with a circle of 8 to 12 winged acute spines

curved outwards; the other less convex, with a circle of more numerous, straight, slightly T-headed spines.

(NOTE.—The above list by no means exhausts the numerous forms belonging to *Stephanopyxis* in this deposit.)

Discs similar to that figured by Dr. O. N. Witt (" Simb. Diat.," Pl. 11, Fig. 13) as the secondary valve of *St. ferox* are extremely common here.

Pyxidicula cruciata, Ehr. (" Prit.," p. 825).—Valve usually oval. Frequent.

Pyxilla Johnsoniana, Grev. (" T. M. S.," Vol. xiii, p. 3, Pl. 1, Fig. 6).—This diatom is described by Greville as having free frustules, but the fact of our having observed two valves connected by the apiculi, induces us to think that it may be a filamentous form. The apiculi are reduced in thickness for some distance from the end, at which place they are connected, looking as if they were spliced together. Frequent. (Pl. V., Fig. 10.)

P. dubia, Grun. (" Van Heurck Syn.," Pl. 83, Bis, Fig. 12). —Not infrequent.

P. ? ? (Pterotheca, Kitt.*)*, *aculeifera*, Grun. (" Van. Heurck Syn.," *l.c.*, Fig. 5; also Kitt. in " J. Q. M. C.," 1871).—A variety of this is frequent.

Stephanogonia danica (Kitt.), Grun. var. (*l.c.*, Figs. 7 and 8). —This form differs from that figured in " Van Heurck Syn.," from the Jutland deposits. The apiculus is more gradually contracted, the angular costæ are more strongly developed, and very conspicuous in the valvular view. The valve is oval and hyaline. Frequent.

Xanthiopyxis oblonga, Ehr. (" Prit.," p. 827, Pl. 5, Fig. 76). —Frequent.

X. constricta, Ehr. (" Prit.," *l.c.*).—Frequent up to ·0025″ in length.

Liradiscus ovalis, Grev. (" T. M. S.," Vol. xiii, p. 5, Pl. 1, Figs. 15, 16).—Not frequent.

Goniothecium odontella, Ehr. (" Prit.," p. 864, Pl. 6, Fig. 29; also Brightw. in " Q. J. M. S.," Vol. iv, p. 106, Pl. 7, Figs. 47, 48). —A variety of this is very common.

Chætoceras gastridium (Ehr.), Grun. var. (" Van Heurck Syn.," Pl, 82, Bis, Figs. 1 and 2).—We have observed several specimens of a form closely resembling this, but with incurved awns.

Dicladia capreolus, Ehr. (Brightw., "Q. J. M. S.," p. 107, Pl. 7, Figs. 53 to 60).—This occurs not rarely, along with forms resembling *Syndendrium diadema*, Ehr., which may be the Sporangia ? of *Chætoceras*.

Small discs are also present abundantly, oval or oblong, with rounded ends, and with a submarginal ring of closely-set puncta. Frustular views of these show two narrow, somewhat umbonate valves, one of which has an inflated centre, bearing a short spine. These may be allied to *Thalassiosira* Cleve, but we are unable to come to any conclusion.

Since the publication of Parts 1 and 2 many more species have been discovered, and further examination has led us to alter our views as to one or two species hitherto included in Biddulphia. Of these we now give particulars, excluding such new forms as we are unable to figure in the plates accompanying this part, but which will be given subsequently in an appendix.

Cymbelleæ.

Amphora furcata, Leud. Fort. ("Diat. de Ceyl.," p. 20, Pl. 1, Fig. 11) = *A. spectabilis*, Greg. ("G. D. C.," p. 44, Pl. 5, Fig. 80). —Rare.

Cocconeideæ.

Cocconeis costata, Greg. ("Q. J. M. S.," Vol. iii, p. 39, Pl. 4, Fig. 10).—Rare.

C. naviculoides, Grev. ("T. M. S.," Vol. xiii, p. 34, Pl. 4, Fig. 24).—Scarce.

Mastogloieæ.

Orthoneis splendida (Greg.), Grun. (*Cocconeis*, "G. D. C.," p. 21, Pl. 1, Fig. 29).—Attains a length of ·0055″, but has finer striæ than the type form, about 22 at centre, and 18 in ·001″ at margin. Not very scarce.

Naviculaceæ.

Navicula braziliensis, Grun. (A. Sch., "Atl.," Pl. 6, Figs. 23-25).—A few fairly typical examples have occurred. Length ·0045″. Striæ about 28 in ·001″. Also a small form with closer striation (40 in ·001″). A form of this species is present which has sublyrate clear spaces, resembling *N. Baileyana*, Grun. (*l.c.*, Figs. 26, 27).

N. sandriana, Grun. (A. Sch., "Atl.," Pl. 70, Fig. 49).—Rare.

N. definita, n. sp., Gr. and St.—Valve large, ovato-lanceolate, with obtuse rounded ends. Striæ subradial, about 40 in ·001″, occupying a space rather exceeding one-quarter of the width of the valve, and having a very distinctly defined clear space on each side of the median line. Central and end nodules dilated transversely. Varies in length and breadth. Typical specimen ·0077″ long, ·0022″ broad. Not very scarce. (Pl. VI., Fig. 11.)

Amphiprora rugosa, Pet. ("Diat. de l'Isle Campbell," p. 29, Pl. 5, Fig. 17).—One specimen pretty closely agreeing with Petit's figure has been brought to our notice by W. J. Gray, Esq., M.D.

A ? ? cornuta, Chase ("Notes on New and Rare Diat.," p. 2, Pl. 1, Fig. 6).—This form, which is certainly not an *Amphiprora*, occurs not infrequently.

FRAGILARIEÆ.

Dimeregramma fulvum (Greg.), Ralfs. (*Denticula*, "G. D. C.," p. 24, Pl. 2, Fig. 38).—Frequent.

Plagiogramma (constrictum var. *?) nancoorense*, Grun. ("Nov.," p. 94, Pl. 1*a*, Fig. 8).—One worn specimen discovered by Herr Weissflog.

P. neo-gradense, Pantocsek ("Diat. Hungary," Pl. 8, Figs. 63 and 71).—Rare.

P. tesselatum, Grev. (" Q. J. M. S.," Vol. vii, p. 208, Pl. 10, Fig. 7).—Narrower than the type. Rare.

Stictodesmis australis, Grev. ("Ed. Trans. Bot. Soc.," Vol. vii, p. 535, Pl. 13, f. 1-4).—Rare.

NITZSCHIEÆ.

Nitzschia grundleri, Grun. (Cleve, "West Ind. Diat.," p. 14, Pl. 4, Fig. 24).—Rare.

N? antiqua, n. sp., Gr. and St.—One perfect valve and several broken specimens have occurred hitherto. The ends suggest *Synedra*, but in general appearance and in the character of the striation, it resembles *Nitzschia*; in which we place it with hesitation. Keel narrow with obscure puncta, surface of valve covered with irregularly arranged dots, which take the form of short parallel lines about 19 in ·001″ close to the ventral margin.

Longitudinal fold not conspicuous. At each end is an ovate projection more closely dotted than the rest of the surface. Length, ·016″; breadth, ·0007″. (Pl. VI., Fig. 12.)

RUTILARIEÆ.

Rutilaria epsilon, Grev. ("Q. J. M. S.," Vol. xi., p. 228, Pl. 9, Fig. 1).—Rare.

R. epsilon, var. *tenuis.*—Differs from the type in its much more slender form and smaller central process. The marginal setæ are distinct and wider apart than in the type. The surface covered with dots forming decussating lines. Scarce. (Pl. VI., Fig. 13.)

BIDDULPHIEÆ.

Biddulphia pedalis, n. sp., Gr. and St.—Valve discoid, ·004″ in diam. with 7 to 8 stout marginal processes curved outwards and upwards. Between each process is a marginal projection. In the centre of the valve is a large flat umbilicus, surrounded by a clear annular space, from which branch narrow radial clear spaces to the base of each process. The rest of the surface is covered with five close-set, radiating lines of granules, among which are large puncta, or spines. Below the surface of the valve, and outside of the circumference, are 14 to 16 feet, or projections, of a semi-circular form, marked with radial lines. Not having seen a frustular view, we are unable to say what appearance these feet or appendages, present in that aspect, and must await an opportunity for further examination. We are indebted to W. J. Gray, Esq., M.D., for the only two specimens of this interesting form hitherto observed. (Pl. VI., Fig. 22.)

B. chinensis, Grev. ("T. M. S." Vol. xiv., p. 81, Pl. 9, Fig. 16. —Scarce.

B. podagrosa, Grev., var. ("T. M. S.," Vol. xiv., p. 82, Pl. 9, Fig. 17).—We have met with several specimens of a form resembling this, but with much shorter horns, which are connected by a keel or web with the inflated centre. There are no traces of spines or claws on the horns.

B. reticulata, Roper., *forma trigona* ("Van Heurck Syn.," Pl. 102, Fig. 3).—Differs from Van Heurck's figure only in the slight concavity of the sides. Cellules very distinctly punctate. Length of side, ·0057″. Scarce.

Kittonia, n. gen., Gr. and St.—Characteristics: Valves with

stalked processes, terminating abruptly in nodular, discoid, or cup-shaped expansions, cellulose, but not furnished with claws or hooks, as in *Hemiaulus*. Other characteristics, those of Biddulphia as defined by Van Heurck ("Syn. Texte," p. 203).

Kittonia elaborata, Gr. and St. (*Biddulphia elaborata*, "J. Q. M. C.," Vol. II., Ser. II., p. 325, Pl. 18, Fig. 9).—This diatom occurs frequently in all the samples of this deposit we have hitherto examined. Specimens vary in size from ·007″ to ·01″ in length, and ·004″ to ·0067″ in breadth.

[We take this opportunity of correcting an error in the scale of measurement attached to Pl. 18, Fig. 9, which should be 400, not 500 diameters.]

K. virgata, Gr. and St. (*Biddulphia virgata*, *l.c.*, p. 325. Pl. 18, Fig. 11).—Since the above-mentioned figure was engraved we have met with a more perfect specimen, of which we now give a figure (Pl. VI., Fig. 23.)

NOTE.—Having, through the kindness of W. Carruthers, Esq., F.R.S., of the Nat. Hist. Mus., been enabled to examine Dr. Greville's authentic specimens of his *Biddulphia gigantea* ("T. M. S.," Vol. XII., p. 13, Pl. 2, Fig. 9), we find that the hyaline stalked processes terminate in nodular cellulose expansions larger than the small capitate ends shown in his figure. We venture to remove the form to this genus under the name of *Kittonia grevilliana.*

Cerataulus polymorphus (Kütz.), *forma minor*, ("Van Heurck Syn.," Pl. 105, Figs. 3 and 4).—A small form occurs very rarely, which we place here. It differs only in the presence of a small central group of spines, in place of the two shown in the Fig. referred to.

Triceratium rugosum, n. sp., Gr. and St.—Very similar in general appearance to *Trinacria heibergii*, Kitt. ("J. Q. M. C.," 1871, p. 169, Pl. 13, Fig. 6), but differing essentially in the form of the processes, which are large, club-shaped, and studded with short spines. Margin convex, extending beyond the edge of the valve. Surface covered with scattered papillæ, presenting a rugose appearance. Length of side about ·005″. Rare. (Pl. V., Fig. 4.)

T. coscinoides, Gr. and St. ("J. Q. M. C.," Vol. II., Ser. II., p. 327, Pl. 19, Fig. 13), var. *quadrata*.—Since describing this species we have met with a four-angled form of the same.

Triceratium papillatum, n. sp., Gr. and St.—Valve small, with deeply concave sides, and enlarged rounded ends, slightly inflated, from which project prominent nipple-shaped processes. Centre inflated. Surface of valve dotted with scattered granules, with a few stout spines interspersed on the central portion. Length of side, ·003″. Very rare. (Pl. VI., Fig. 14.)

For the specimen from which the figure is taken we are indebted to the kindness of Herr Weissflog.

T. bimarginatum, n. sp., Gr. and St.—Valve small, with straight sides and slightly rounded angles bearing distinct circular nodules. Central part elevated, bounded by a margin of closely-set puncta, which form an inner triangle, having sides parallel with the outer margin. Length of side ·0014″. Not frequent. (Pl. VI., Fig. 15.)

T. auliscoides, n. sp., Gr. and St.—Valve small, with rounded angles and mastoid processes resembling those of *Auliscus*. The sides are produced into obtuse angles between the processes giving an hexagonal appearance to the whole form. Surface minutely punctate with markings like those of *Auliscus pruinosus*. There is an indication of an umbilicus, and the angles are isolated by an indistinct clear space, giving to the central markings the form of a concave triangle. Very rare. (Pl. VI., Fig. 16.)

We are indebted to W. J. Gray, Esq., M.D., for the specimen from which the figure is taken.

T. montereyii, Brightw. (" Prit.," p. 856, also " Q. J. M. S.," p. 251. Pl. 4, Fig. 18).—Not common, but typical.

Aulacodiscus crux, Ehr.—A form of this with three processes has been observed. A small variety with two processes is not infrequent, which is not unlike *A. probabilis*, A. Sch., but seems to belong to this species.

A. margaritaceus, Ehr.—A beautiful form of this has been brought to our notice by F. Kitton, Esq. The centre is deeply depressed, and the exterior elevated after the manner of *Craspedodiscus elegans*. The diam. is ·0095″, it has six processes, and is otherwise quite typical.

A. angulatus, Grev., a variety with four processes, is not very rare in the lighter density.

Hemiaulus amplectans, n. sp., Gr. and St.—We place this peculiar form in *Hemiaulus* solely on account of the general resemblance it bears to some species of that genus.

The apparent absence of the characteristic claws or spines at the ends of the horns would place it in *Biddulphia;* and there are perhaps better reasons for giving it a genus of its own, but for the present we leave it here.

Valve resembling in general appearance that of a *Hemiaulus*, hyaline, produced at the ends into horns which project at right angles to the surface of the valve, and are slightly tapering, with rounded ends. The horns are distinctly cellulate. The most remarkable feature in this little form is the presence of a very long, stout central spine, terminating in a bent claw or fork, by which the spine, projecting from the opposite valve, is clasped: each spine being embraced or clasped by the fork of the contiguous valve. The spines appear to be able to move freely through the forks, so that the valves are sometimes found near together and at others wide apart. Length of valve usually about ·001″; length of horns about ·001″; length of central spine, ·0025″. Scarce. (Pl. VI., Fig. 17.)

H. ornithocephalus, Grev.—The form mentioned under this name (ante, Part II, p. 11) appears to differ somewhat from Greville's figure. We append figures of valve and frustule. (Pl. VI., Figs. 18, 19.)

Anaulus birostratus, Grun. ("Van Heurck Syn.," Pl. 103, Fig. 1).—A small form of this occurs rarely. (Pl. VI., Fig. 25.)

Eunotogramma ?? bivittata, Grun. and Pant. (Pant. "Diat. Hungary," Pl. 26, Fig. 247).—Valve lunate, long, narrow, tapering, with curved dorsal and ventral margins. Two septa or vittæ nearer to the centre than the ends. Surface dotted with scattered granules, which are most numerous at the margins. Not infrequent. (Pl. VI., Fig. 24.)

We have figured a normal specimen, but have observed some of much greater length and curvature, resembling in form *Eunotia lunaris*.

Note.—We had named this form *Anaulus tenuis*, but discovering that it had been found in the Hungarian fossil marine deposits, and was published in Herr Pantoczek's work under the name given above, we adopt his nomenclature.

Terpsinoe americana, Bail., (Ralfs in "Prit.," p. 859).—Scarce.

Auliscus punctatus, Grev. ("T. M. S.," Vol. xi., p. 49, Pl. 3, Figs. 15, 16).—A small form, not uncommon.

A. Grevillei, Jan. ("Guano," p. 163, Pl. II., Fig. 11).—Typical, scarce.

A. (*pruinosus* var. ?) *confluens*, Grun. (A. Sch. "Atl.," Pl. 32, Figs. 6-8.)—Scarce.

A. Hardmanianus, Grev. ("T. M. S.," Vol. xiv, p. 6, Pl. 2, Fig. 17).—Small specimens occur rarely.

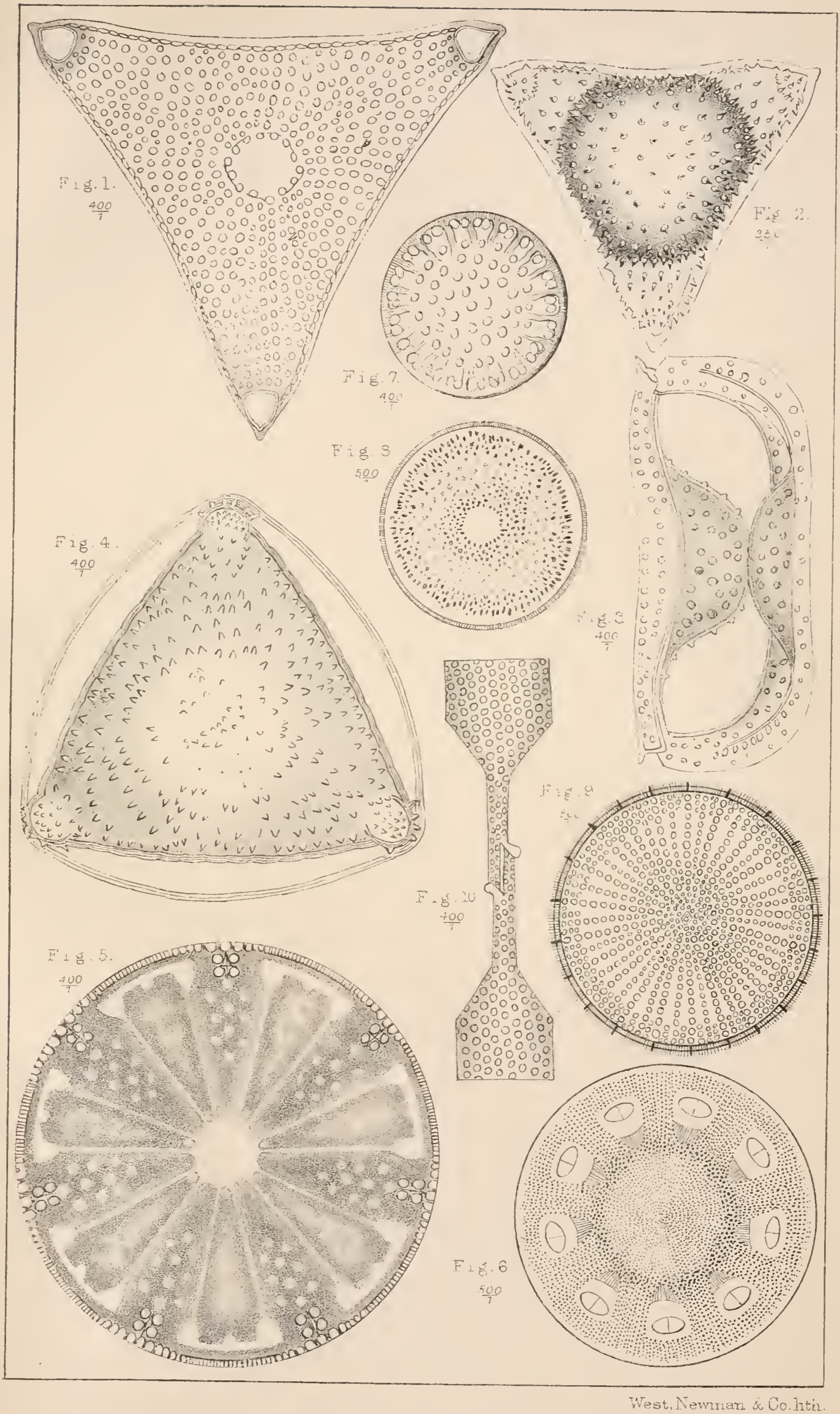
Clavicula aspicephala, Pant. ("Diat. Hungary," Pl. 2, Fig. 15). —Several fragments of this species have been observed.

PLATE V.

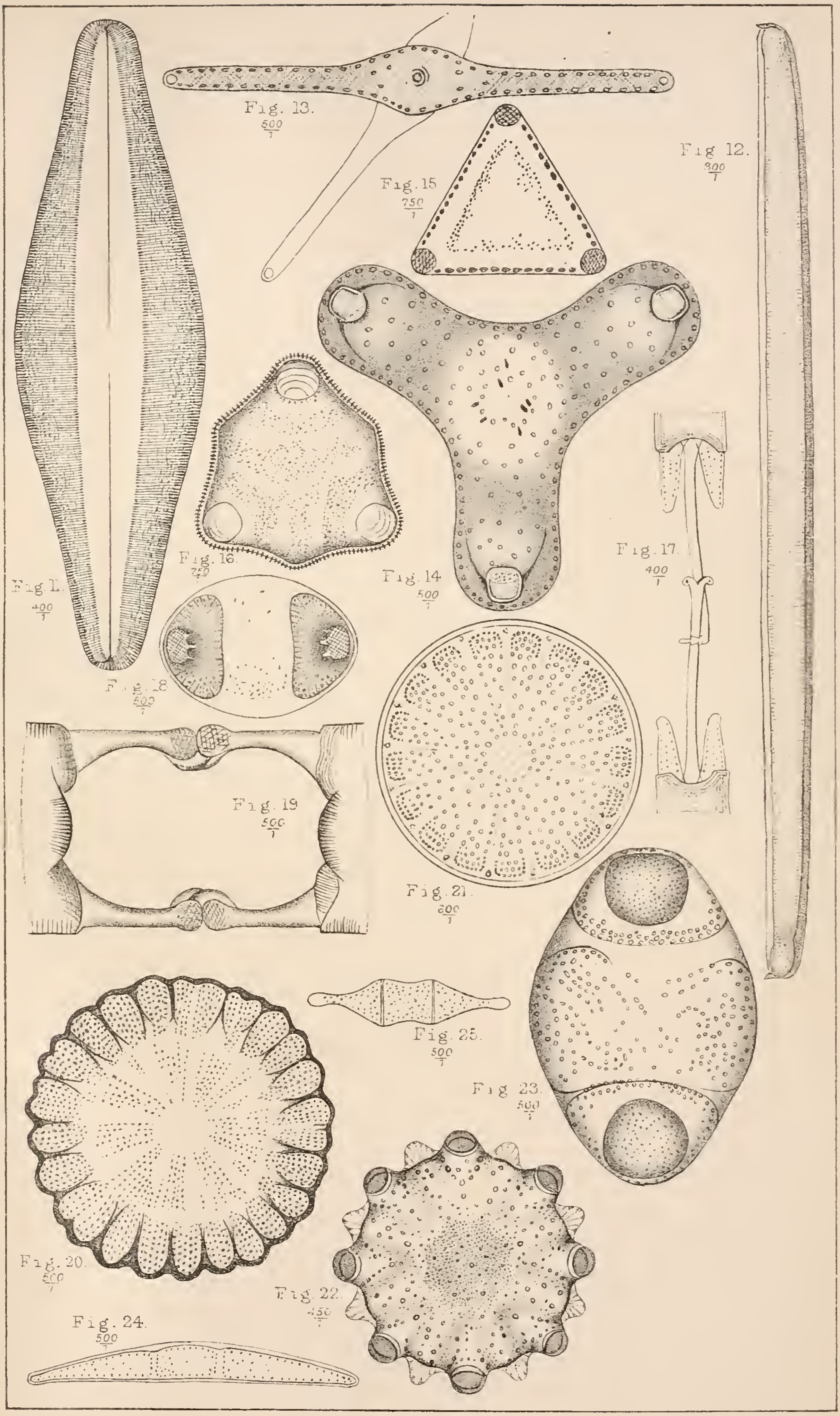
FIG. 1. *Trinacria ventricosa*, n. sp., Gr. and St., primary valve, $\frac{400}{1}$.
" 2. " " " " secondary valve, $\frac{350}{1}$.
" 3. " " " " frustular view, $\frac{400}{1}$.
" 4. *Triceratium rugosum*, n. sp., Gr. and St., $\frac{400}{1}$.
" 5. *Actinoptychus vulgaris*, Schum., var. *maculata*, Gr. and St., $\frac{400}{1}$.
" 6. *Craspedoporus elegans*, n. sp., Gr. and St., $\frac{500}{1}$.
" 7. *Stictodiscus californicus*, Grev., var. *nitida*, Gr. and St., $\frac{400}{1}$.
" 8. *Porodiscus interruptus*, n. sp., Gr. and St , $\frac{500}{1}$.
" 9. *Coscinodiscus elegans*, Grev., var. *spinifera*, Gr. and St., $\frac{500}{1}$.
" 10. *Pyxilla Johnsoniana*, Grev., frustular view, $\frac{400}{1}$.

PLATE VI.

" 11. *Navicula definita*, n. sp., Gr. and St., $\frac{400}{1}$.
" 12. *Nitzschia antiqua*, n. sp., Gr. and St., $\frac{300}{1}$.
" 13. *Rutilaria* (*epsilon* var.?) *tenuis*, n. sp., Gr. and St., $\frac{500}{1}$.
" 14. *Triceratium papillatum*, n. sp., Gr. and St., $\frac{500}{1}$.
" 15. *T. bimarginatum*, n. sp., Gr. and St., $\frac{750}{1}$.
" 16. *T. auliscoides*, n. sp., Gr. and St., $\frac{750}{1}$.
" 17. *Hemiaulus amplectans*, n. sp., Gr. and St., $\frac{400}{1}$.
" 18. *H. ornithocephalus*, Grev., var. side view, $\frac{500}{1}$.
" 19. " " frustule, $\frac{500}{1}$.
" 20. *Anthodiscus floreatus*, n. sp., Gr. and St., $\frac{500}{1}$.
" 21. *Cosmiodiscus Normanianus*, Grev., $\frac{600}{1}$.
" 22. *Biddulphia pedalis*, n. sp., Gr. and St., $\frac{450}{1}$.
" 23. *Kittonia virgata*, n. sp., Gr. and St., $\frac{500}{1}$.
" 24. *Eunotogramma ? ? bivittata*, Grun., $\frac{500}{1}$.
" 25. *Anaulus birostratus*, Grun., $\frac{500}{1}$.



West, Newman & Co. lith.



West, Newman & Co lith.

On the Structure of Aulacodiscus Margaritaceus, Ralfs.

By Henry Morland.

(Read March 25th, 1887.)

In a paper on "Diatom Structure," which I read before this Club in May last, I gave the following description of the structure of the valves of *Aulacodiscus margaritaceus* of Ralfs :—"The inner surface consists of a layer with small perforations, some $\frac{1}{12000}$ inch across, with thickened borders; above this is a framework of tubes (one to each perforation below), with more or less straight-sided borders. Some of these tubes have 4, 5, or 6 sides, and they are by no means regular in shape. As the outward surface is approached the angles get filled up, and the irregularly-shaped cells end in circular openings rather smaller than the cells themselves."

I have lately been examining this diatom again, but this time under an oil immersion lens, and find that I must modify the above description, which, however, is correct so far as the coarser structure is concerned, but misses the finer details.

I described the irregularly-shaped cells as ending in "circular openings" on the outer surface. This, I can now emphatically say, was a mistake, these cells really being closed at the outer surface of the valve by a very fine siliceous film with markings very similar to those of *Coscinodiscus asteromphalus*, Ehr., as figured by Messrs. Nelson and Karop, a year ago, in our Journal. With respect to the small perforations on the inner layer, I find in the examples I have examined that they are furnished with very short tubes projecting inwards towards the body of the frustule, these tubes giving a "ringed" appearance to the perforations when the valve is examined direct on the inner surface. As yet I have been unable to detect any film across these inner perforations, but there are Diatomists who seem to be of opinion that these "eye-spots" also are closed by a membrane, though, perhaps, but very slightly silicified.

In the case of *C. asteromphalus*, I consider the markings in each set of markings, as figured by Messrs. Nelson and Karop, to be really those of a siliceous film across and slightly within the mouth of each polygonal cell, as in *Aulacodiscus margaritaceus.* If *Coscinodiscus asteromphalus* be examined from the inner side of valve, "eye-spots" will be seen under a very medium power.

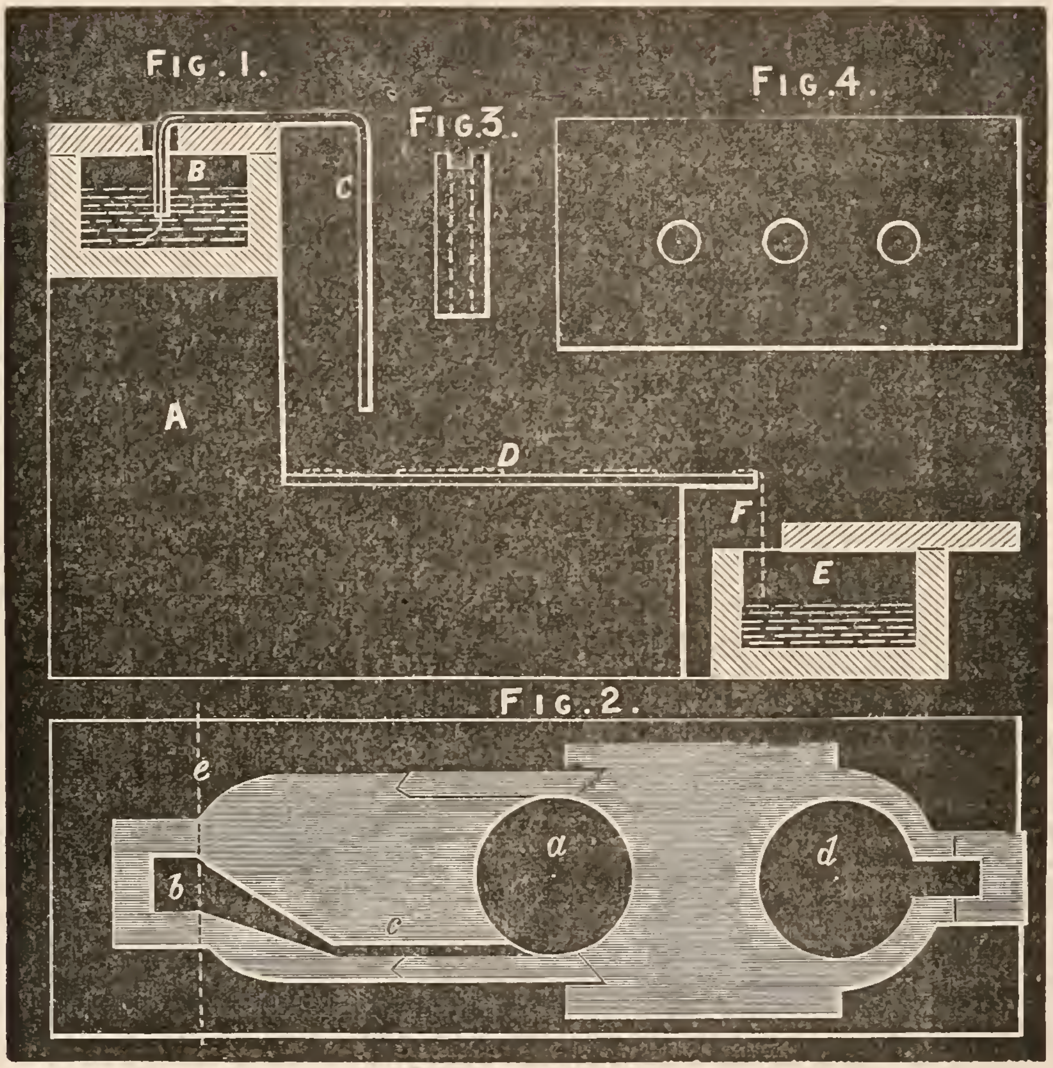
I think that further and careful examination under suitable lenses will show that *all* valves with "eye-spots" on the inner surface of valve have their hexagonal, or rather polygonal, cells, when present, closed on the outer surface, with delicate siliceous films pierced with sets of extremely fine and minute perforations.

It must be understood that these remarks of mine in no way apply to *Triceratium favus*, respecting which I must make further examinations before offering a definite opinion relative to its structure.

On a New Arrangement of Growing Slide, designed by the Rev. A. Pagan, B.A.

Communicated by T. Spencer Smithson.

(Read March 25th, 1887.)



This slide was designed mainly for the purpose of watching the development of Rotifers and other organisms which require a constant change of water. The above figures give the essential points of its construction, which is very simple, and so far effective as to have enabled Mr. Pagan to observe the growth of the spores of *volvox globator* after they had been

confined to the slide for six weeks, the actual process of germination taking three days to complete.

Fig. 1 is a longitudinal vertical section of the whole apparatus drawn to a scale of half the actual size; A is a wooden stand supporting a glass trough (B), from which a water supply is conveyed to a slide (D) by a siphon (C). This siphon is made from an ordinary, capillary, vaccine tube, bent over a minute gas flame. The water is conveyed from the slide by means of a spout (F), made of blotting-paper, to another trough or suitable receptacle (E).

Fig. 2 shows in full size an arrangement cut out of blotting-paper and placed on an ordinary slide; *a* is a circular hole for containing the object under observation. This hole is connected by a narrow channel (*c*) with another hole (*b*), shaped as in the drawing, and so placed beneath the siphon *c* as to receive a drop of water as it falls. It is sufficient, however, if the drop falls on the blotting-paper. A third hole (*d*) serves to collect the superfluous water, and also acts as a reservoir when the slide is under examination with the microscope, water being applied there from time to time with a camel's-hair brush.

When it is desired to use the instrument the blotting-paper is wetted and put on the slide, the drop of water containing the organism placed in the hole *a*, and the whole is covered with thin glass up to the dotted line *e*,.three $\frac{3}{4}$-in. square cover glasses being very suitable for this purpose. The siphon may now be started, the current being regulated to about one drop per minute by means of a linen thread, unravelled, soaked in water to get rid of air bubbles, and pushed up the shorter limb of the siphon. The water is drawn off at the other end of the slide by three strips of blotting-paper (shown detached at Fig. 3), one broad and the other two less than half the width placed under the broad slip, thus forming a kind of channel for the water to flow through.

After a time the blotting-paper is liable to get clogged, and will not allow the water to filter through; it must therefore be changed. To enable this to be done, the part used on the slide is cut in pieces in the manner indicated in Fig. 2.

The form of the lid of the trough B is shown in Fig. 4; it is provided with three holes drilled one inch apart, in order

that, when desired, three separate slides can be kept under treatment at the same time.

Mr. Pagan has been good enough to allow me to bring his invention before the Club, and I have much pleasure in doing so, as I think it supplies a want that has been long felt by microscopists, and it is capable of doing a large amount of valuable work in elucidating problems in the life history of the many organisms which still remain very imperfectly known, owing to the difficulty of watching their development during lengthened periods.

PROCEEDINGS.

January 14th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Coryne pusilla (allied to Syncoryne.) ...	Mr. F. W. Andrew.
The Scissor Bug, *Heterotoma merioptera*, with drawing of same	Mr. F. Enock.
Lipura, sp.	Mr. C. Rousselet.
Absorption spectra of *Cantharides*	Mr. H. J. Waddington.
Embryo (40 hours incubation) of chicken ...	Mr. W. Watson.
Actinomycosis in tongue of ox	Mr. G. Western.
An apo-chromatic 1in. object glass by Zeiss ...	Mr. E. M. Nelson.

Attendance—Members, 32 ; Visitors, 2.

January 28th, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., President, in the chair.

The minutes of the meeting of November 21st, 1886, were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Messrs. E. T. Browne, A. S. Lightwood, and E. Grove.

The following additions to the Library and Cabinet were announced :—

"Proceedings of the Royal Society," Nos. 248-9	From the Society.
"Proceedings of the Royal Society of New South Wales"	From the Society.
"Journal of the New York Microscopical Society"	" "
"The Botanical Gazette"	In Exchange.
"The American Monthly Microscopical Journal"	" "
"Proceedings of the Belgian Microscopical Society"	" "
"Proceedings of the Eastbourne Natural History Society"	" "
"Proceedings of the Canadian Institute of Toronto"	" "

"Annals of Natural History"	... ...	Purchased.
"Cooke's British Desmids"	... ...	„
12 Slides prepared by the late Mr. W. T. Loy		From Mr. T. Curties.

The President called special attention to the last-named donation, which consisted of a number of preparations mounted by the late Mr. Loy, for many years a member of the Club, and one whose manipulative skill was well known to all those who were acquainted with him. These slides had been presented to the Club by Mr. Curties, as typical examples of Mr. Loy's work, and as such the members would no doubt be extremely glad to possess them, and also to return a special vote of thanks to Mr. Curties for presenting them.

Votes of thanks to the donors, especially to Mr. Curties, were unanimously carried.

The President reminded the members that, in accordance with their altered rules, the annual meeting of the Club would be held on February 25th, and that it was, therefore, necessary for them to nominate gentlemen to serve as officers and committee during the ensuing year, such nominations to be printed upon the balloting papers in the usual manner for election at the annual meeting. It would also be necessary to elect an auditor to examine the accounts to be presented to the annual meeting by the Treasurer on behalf of the Club.

The Secretary read the following list of nominations by the Committee as officers:—For President, Mr. A. D. Michael; Vice-Presidents, Professor Chas. Stewart, Mr. E. M. Nelson, Mr. E. T. Newton, Mr. J. W. Groves; other officers as before.

On behalf of the Committee, Mr. W. Hainworth was appointed auditor.

The Secretary pointed out that in addition to the four members whose turn it was to retire by rotation—Messrs. Dadswell, Fase, Gregory, and Waddington—three other vacancies would occur on the Committee from the elevation of Messrs. Nelson, Newton, and Groves to the Vice-Presidency, so that the members were asked to nominate at least enough names to fill up these seven vacancies.

The President having formally requested nominations to be made—Mr. Dadswell was proposed by Mr. Spencer, and seconded by Mr. Dunning; Mr. Stokes was proposed by Mr. Parsons, and seconded by Mr. Hembry; Mr. Morland was proposed by Mr. McIntire, and seconded by Mr. Nevins; Mr. Sturt was proposed by Mr. Dadswell, and seconded by Mr. Waller; Mr. Parsons was proposed by Mr. Priest, and seconded by Mr. Vesey; Mr. Vesey was proposed by Mr. Hembry, and seconded by Mr. Western; Mr. Waddington was proposed by Mr. Dunning, and seconded by Mr. Alpheus Smith.

As auditor, on behalf of the members, Mr. Hind was proposed by Mr. Dunning, and seconded by Mr. Alpheus Smith, and unanimously elected by show of hands.

Mr. E. M. Nelson then said: I have much pleasure in bringing before you to-night a new microscope which has been made by Mr. C. Baker, and which I think you will all admit begins a new era in the progress of

"microscopy" (see Fig. 5). You have before you now for the first time in the history of the microscope a thoroughly sound full-sized instrument at the same price as a student's microscope. I must say that we are all greatly indebted for the construction of this instrument to the energy and perseverance of Mr. Charles Lees Curties. I will, if you will allow me, just go over some of the points adopted in this new microscope. I say adopted, for in a new microscope there must of necessity be much that is old in design, &c. All that can be expected is that some of the points are to be new. This, therefore, will be found to be an aggregation of late improvements with some new excrescences added. Let us begin with the foot

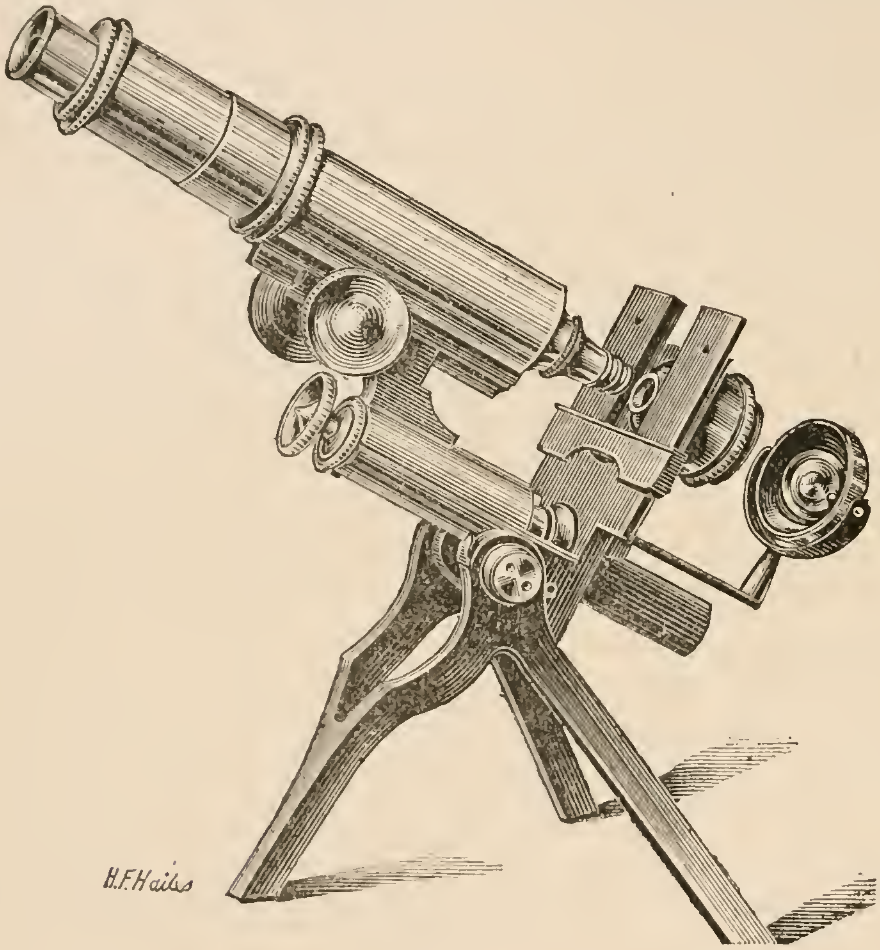


Fig. 5.

(a most important part). All microscope feet may be classified under four heads: 1st. The simple tripod, illustrated by the Powell form. 2nd. The plate and uprights. A flat plate with pillar or pillars, as in the Beck model, and a plate with flat uprights in the Andw. Ross. 3rd. The bent claw, a very common and bad form, used by many makers. 4th. The heavy horseshoe, the usual Continental model. The plate and uprights is a good form, but was not adopted, because it is too heavy and expensive. The bent claw is a bad form. It is suprising that it has not disappeared long ago. It is heavy, easily capsized, and while seemingly a tripod, often rocks on four points. The heavy horseshoe which, until lately, was always fitted to students' microscopes, has nothing to recommend it. A designer must indeed be hard up for resources who can only obtain steadiness by weight. There can be no question but that the tripod in its simplest form is the best. Of all the ways of utilizing it, that adopted by Messrs Powell and Lealand

is the most efficient, viz., of hanging the microscope in a horseshoe, supported by three legs; but for this class of instrument that mode of mounting was quite out of the question, for cost immediately put it outside the category of students' microscopes. There is a great difference between the steadiness of a microscope perched up on the top of its trunnions and one that is hung in a tripod. This microscope is placed in a kind of stirrup hanging from the trunnions, a most ingenious device of Mr. Curties. The body is large enough to take Zeiss' full-sized eyepiece, viz., 1⅜in., and is 10in. long when the draw-tube is pulled out to a mark. When the draw-tube is pushed home the length is 6·3in., or Continental gauge. It, therefore, will suit both kinds of apochromatic object glasses. The optic axis of the instrument, when in a horizontal position, is 8½in. from the table. It has rackwork coarse adjustment, and Campbell's fine adjustment. It is to this fine adjustment that the instrument owes its origin. The moment Mr. Campbell explained to me the principle of his fine adjustment, I foresaw the construction of an efficient students' microscope. The direct-acting screw is only suitable for low powers and small apertures. I will put it even stronger: delicate work with high powers and wide apertures is not possible with any microscope having a direct-acting screw fine adjustment. The stage is of the cut horseshoe form, which I had the honour of bringing before you some little time back. The principal object of this is to enable you to feel your working distance. A great improvement has been made in the sliding bar, its guiding lugs being stowed away underneath the stage; I have no hesitation in saying that next to a perfect mechanical stage this is the best. Most of the mechanical stages are so defective in design, and so scamped in their workmanship, as to be worse than useless. The substage is fitted with a tube, having a spiral slot for focussing, which I will pass over, as I have described it here on a former occasion. There is a novel feature about the stops for dark ground illumination, viz., there is a three-legged carrier which holds them all. This carrier has a pin in the centre of it on which the various sized discs fit. The stops, diaphragms, &c., have a separate tube-fitting for them, so that it is unnecessary to move your condenser when changing either a stop or a diaphragm. This substage will carry either of Prof. Abbé's condensers, or a cheap condenser made especially for this microscope. The weight of the instrument complete is 7lbs.

Mr. John Mayall, jun., said that knowing well Mr. Nelson's thorough competence to give a reliable opinion upon any matter connected with the mechanical construction of the microscope, there could not be the slightest doubt that the one he had just described had some very excellent points. Indeed, he thought they might take it for granted that if the instrument before them had successfully passed Mr. Nelson's criticism, it must be pretty nearly all right. It occurred to him, however, that the spiral arrangement employed for focussing the condenser was, perhaps, not likely to prove quite so true as could be desired, and he should like to ask if Mr. Nelson had found that it introduced any very great error in centring.

Mr. Nelson said he had not observed this to any inconvenient degree except in cases where very high powers were used.

Mr. Mayall thought also that there would be some advantage, both as regarded strength and appearance, if the arm of the limb was made somewhat stouter—it struck him as being disproportionately light; but as to the advantages of the tripod form of foot, he could entirely endorse every word which had fallen from Mr. Nelson on the subject.

Mr. Karop said he fully agreed with Mr. Mayall that the arm of this and similar microscopes was too slender. Even if it were in reality strong enough, it did not give the appearance of being so, which was a fault in the design. Workmen seemed very much addicted to cutting away the metal, quite irrespective of anything but figure, and he instanced the case of surgical knives, where both blade and handle were of a suitable strength, although where they joined, and where the greatest leverage must occur, it would mostly be found that the workmen had ground away the steel to a ridiculous extent, leaving but a thin bridge of metal to take the strain.

Mr. Nelson further called the attention of the meeting to a number of drawings illustrating the remarkable variety of shapes which he had found amongst the hairs of a species of acarus. Also to some drawings of interesting fragments of *Coscinodiscus* and other diatoms.

The President said the number of forms found amongst the hairs of the Acarina was practically endless—the hairs in *Trombidium* seemed, in fact, to vary in almost every species. He felt sure it was unnecessary to say that they thanked Mr. Nelson very heartily for the communications he had made to them.

A vote of thanks to Mr. Nelson was then put and carried unanimously.

Mr. John Mayall, jun., then gave an extremely interesting account of his recent visit to Jena.

The President said that at that late hour of the evening, although it was not possible to invite any questions to be asked upon the subjects which had been brought before them, he was quite sure that all present would cordially respond to the proposal that a hearty vote of thanks be presented to Mr. Mayall for his very interesting narrative.—Put and carried by acclamation.

Messrs. Schrœder exhibited a new method of showing opaque objects with the lieberkuhn.

Announcements of meetings, &c., for the ensuing month were then made, and the meeting terminated with the usual Conversazione, and the following objects were exhibited:—

Coralline, *Clava squamata*	Mr. F. W. Andrew.
Serial Sections of Slug, *Limax agrestis*, cut by Mr. J. Underhill	Mr. H. E. Freeman.

Attendance—Members, 41; Visitors, 8.

February 11th, 1887.—Conversational Meeting.

The following objects were exhibited:—

Young Salmon alive	Mr. F. W. Andrew.
Pollen of *Victoria Regia*	Mr. E. T. Browne.
Palate of Garden Spider, *Epiera diadema* ...	Mr. T. Curties.
Diatoms from Richmond, Virginia	Mr. C. Dunning.
Cirrus of *Balanus*	Mr. J. D. Hardy.
Chröococcus turgidus	Mr. G. E. Mainland.
Diatoms, *Auliscus Stockhardti*	Mr. H. Morland.
Secondary markings on *Euphyllodium spathulatum* and *Cocconeis Grevillii* ...	Mr. E. M. Nelson.
Echinocyamus pusillus from Naples ...	Mr. B. W. Priest.
Laurentian Gneiss from Cape Wrath ...	Mr. G. Smith.
Paramæcium bursaria	Mr. J. Spencer.
Fairy Fly, *Litus cynipseus*	Mr. J. J. Vezey.

Attendance—Members, 47; Visitors, 4.

February 25th, 1887.—Twenty-First Annual Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding Meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. A. F. Tate, Mr. W. F. B. Knight, Mr. F. S. Pim, Mr. Wm. Gross, Mr. George Paterson, and Mr. Jas. T. Hillier.

The following additions to the library were announced:—

"Proceedings of the Royal Society of New South Wales"	From the Society.
"Botanical Gazette"	In Exchange.
"Proceedings of the Belgian Microscopical Society"	"
"Annals of Natural History"	Purchased.
"British Desmids," Nos. 7 and 8	"
Rainey's "Mode of Formation of Shells of Animals"	From Mr. Hind.

The thanks of the Club were voted to the donors.

Announcements of meetings for the ensuing month were then made, and the business of the Annual Meeting was proceeded with.

On the motion of Mr. J. W. Reed, seconded by Mr Gregory, Mr J. D. Hardy and Mr. S. J. McIntire were appointed scrutineers, and the ballot was taken for the election of Officers and Committee for the ensuing year. It was subsequently announced by the President that the whole of the gentlemen whose names appeared on the printed lists were unanimously elected.

The Secretary read the 21st Report of the Committee for the 17 months ending December 31st, 1886.

The Treasurer read his statement of accounts for the same period.

It was moved by Mr. Morland, and seconded by Mr. Vesey, "That the reports now read be received and adopted, and that they be printed and circulated in the usual manner."

The President having put the motion to the meeting, it was unanimously carried.

The President then read his Annual Address.

Mr. E. M. Nelson rose with much pleasure to propose a hearty vote of thanks to the President for the very charming address to which they had just been listening. For his own part, he could say that it had been particularly interesting as dealing with matters which did not ordinarily come under his notice, taking as he did rather the mechanical side of natural history subjects. He had been very much appalled by the question as to what fearful catastrophe would happen to anyone at the edge of space, but he knew what his duty was when he stood at the edge of time; and, therefore, at that hour of the evening he would say no more in favour of a motion which he felt would commend itself to all who were present.

Mr. Waller having seconded the motion, it was put to the meeting by Mr. Nelson, and carried by acclamation.

The President said he had talked so much already that he would only now thank the members for the vote of thanks which they had so kindly passed.

Mr. Weston moved "That the best thanks of the members be given to the President, Officers, and Committee of the Club for the services they had so efficiently rendered during the past year and a half."

Mr. John Pearson having seconded the motion, it was put to the meeting and unanimously carried.

Mr. Spencer proposed a vote of thanks to the Auditors and Scrutineers, which was seconded by Mr. Enock, and carried unanimously.

A vote of thanks to the Council of University College, for continued permission to meet in that building, was proposed by Mr. Hardy, seconded by Mr. Dunning, and carried unanimously; and the proceedings terminated with the usual Conversazione, and the following objects were exhibited:—

Paludicella Ehrenbergii	Mr. F. W. Andrew.
Pollen of *Gœthea Makoyana*	Mr. E. T. Browne.
Battledore wing Fly, *Mymar pulchellus* ♂, and drawing of same	Mr. F. Enock.
Comose appendices of seed of *Strophanthus hispidus*, an African arrow poison	Mr. H. Epps.

Attendance—Members, 64; Visitors, 4.

March 11th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Marine Hydrozoa, *Pedicellina cernuæ* ...	Mr. F. W. Andrew.
Pollen of *Gœthea makoyana*	Mr. E. T. Browne.
Seeds of Clematis	Mr. A. L. Corbett.
Scale of *Podura,* with dark ground illumination, Zeiss' apochromatic objective, 6·0 mm. (¼in.), and Abbé condenser, 1.20 N.A.	Mr. C. Lees Curties.
Oak Apple Fly, *Andricus terminalis,* with drawing of same	Mr. F. Enock.
Foraminifera, *Cristellaria rotulata,* and section of *Alveolina quoii*	Mr. H. F. Hailes.
Parasite of Tortoise	Mr. C. K. Jaques.
Diatoms, *Actinoptychus seductilis*	Mr. H. Morland.
Fossil Sponge, *Catoptychus agaricoides* ...	Mr. B. W. Priest.
Diatoms from Oamaru, *Biddulphia pedalis,* n.s.	Mr. G. Sturt.

Negative and prints of *Amphipleura pellucida,* photographed with Zeiss' apochromatic 3mm. (⅛in.), O.I., N.A. 1·40, and projection eye-piece, by Dr. E. C. Bousfield and Mr. C. Lees Curties.

Attendance—Members, 39 ; Visitors, 1.

March 25th, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Messrs Isaac Robinson and S. Broad were balloted for and duly elected members of the Club.

Mr T. F. Smith, 12, Campdale Road, N.W., was proposed for election at the next meeting.

The following additions to the Library were announced :—

"Proceedings of the Royal Society" ...	From the Society.
"Proceedings of the Essex Field Club" ...	,, ,,
"Transactions of the Northumberland and Durham Natural History Society"	,, ,,
"American Naturalist"	In Exchange.
"Strasburger's Practical Botany"... ...	Purchased.
Vol. ii. "Bucton's Larvæ," Ray Society ...	,,

Mr. E. M. Nelson exhibited an adapter for Powell's new achromatic oil immersion condenser which enables the stops to be more easily changed.

Mr. B. W. Priest read a paper on the "Calcareous Sponges."

Mr. Waller said that the thanks of the Club were due to Mr. Priest for his excellent *résumé* of this interesting group, and he hoped it would be the means of inducing more members to take up the study of the sponges generally. The material was readily obtainable by any visitor to the sea-

side, scarcely any mass of algæ cast up by the waves being without at least a few specimens of the ordinary kinds.

Professor Stewart, while cordially endorsing all that had been said by Mr. Waller, would rather join issue with Mr. Priest in regard to one or two points. Firstly, as concerned the position of the radiant canals in the *Sycon* figured in his diagram; and, secondly, as to there being no recognizable rudimentary nervous system in the Spongiadæ. With regard to this latter, he was strongly of opinion a nervous system did exist. The external openings of the inhalent inter-radial canals in *Lycon compressa* showed delicate hair-like processes of the Ectoderm, each having its axis traversed by a fine thread of protoplasm derived from a subjacent branched mecoderm cell. He regarded the hair-like process as a sensory mechanism which, acted upon by special features in the water, transmitted the impression to the cell beneath (nerve cell), and from this impulses would be given off to the contractilecells in its neighbourhood, so that the orifices of the inter-radial canals might be closed or opened, and the current of water regulated.

Mr. Priest, in reply, stated his own belief in the possession of a nervous system by the Calcaria ; he, however, quoted Dr. Polègaeff, a recent observer, as holding a contrary opinion.

A vote of thanks to Mr. Priest for his paper was put from the chair, and carried unanimously.

Mr. Morland read a short paper on "The structure of *Aulacodiscus margaritaceus*."

Mr. Nelson said he had also observed the appearances as described by Mr. Morland.

A unanimous vote of thanks was passed to Mr. Morland for his communication.

The Secretary then read a description of a new growing slide sent by Mr. Smithson, of Rochdale.

Mr. Karop said he thought the idea very good, and much superior to the "hanging drop" arrangement, where the upper surface of the cover glass frequently got dimmed in the moist chamber, and the dimness was with difficulty got rid of without disturbing the specimen.

A vote of thanks was passed to Mr. Smithson for his communication.

Mr. Karop then gave a short description of some new Lieberkuhns exhibited by Messrs. Schroeder, made of Wolfram steel, and which could be used with magnifications of over 400 diams. The apparatus was exhibited by Messrs. Schroeder in the room, and he thought was worthy of note.

A vote of thanks was passed to Messrs. Schroeder for their exhibit.

Mr. Karop said there was a little matter he should like to say a few words about before the meeting broke up, and also to get some information himself. Mr. Richardson, a member of the Club, had sent him some deposits containing Diatoms from Scotland, and one of them, from Loch Kinnord, Aberdeenshire, was very rich in the ordinary lacustrine forms, such as *Epithemia*, *Synedra*, *Cymbella*, &c., &c. It contained very little foreign matter, and was easily cleaned. Another deposit, however, from

Skye, was mixed with a quantity of white material which resisted all the ordinary acids, and he supposed was a silicate of magnesia; at any rate it gave a milky colour to the washings, and was so fine as not to subside in any ordinary time. He wished to know how to proceed in such cases.

Mr. Morland had found that alternate treatment with H_2 SO_4, and liq. potassæ several times repeated was sometimes efficacious in getting rid of refractory material.

Mr. Karop said he was rather afraid of liq. potassæ with diatoms, but Mr. Morland was a great authority in this direction, and he was much indebted to him for his suggestion.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated in the usual Conversazione, and the following objects were exhibited:—

Alga, *Vaucheria*, sp.	Mr. F. W. Andrew.
Mouse Flea, *Pulex musculi*	Mr. E. T. Browne.
Plant Bug, *Calocoris bipunctatus* ♂ ...	Mr. F. Enock.
Organisms found in tube of a carbon filter, *Protococcus*, Diatoms, *Amœba*, Nematoid worms, Infusoria, and *Rotifer vulgaris*	Mr. G. E. Mainland.
Moving bubbles in quartz	Mr. E. M. Nelson.
Young tadpole, showing cilia in tufts covering the whole animal	Mr. C. Rousselet.
Serial set of sections through a young frog ...	Mr. W. Watson.

Attendance—Members, 46; Visitors, 4.

REPORT OF THE COMMITTEE.

February 25th, 1887.

In presenting this, the Twenty-first Report, your Committee have at the outset to draw attention to the fact that, in consequence of the alteration in the date of the Annual General Meeting, which will be referred to later on, it is a record of the Club's affairs for the past seventeen months.

The general status of the Club has remained practically unaltered during this period.

Twenty-six new members have been elected since the last report, and 13 have resigned. Death has removed 11, among whom we have to deplore no less than three past Presidents, viz., Dr. W. B. Carpenter, C.B., F.R.S., Dr. T. Spencer Cobbold, F.R.S., and Dr. John Matthews; the others being Mr. H. H. Dobson, who officiated several times as Auditor; Mr. Scofield, Mr. John Spencer, Mr. Rhein, the lithographer; Mr. W. T. Loy, Lieut.-Col. Salkeld, Mr. Henry Davis, and Mr. W. B. Leighton.

The meetings have been well attended, and a fair number of valuable papers submitted to them.

The following is a list of the more important:—

1885.

Oct. 23. "On a New British Species of Vaucheria," by Dr. M. C. Cooke.

Nov. 27. "On some Microscopical Antiquities," by Mr. E. M. Nelson.

1886.

Jan. 22. "On Spongia fragilis," by Mr. B. W. Priest.

"On a New Form of Fine Adjustment," by Mr. E. M. Nelson.

Feb. 26. "On a Parasite of the Mole," by Mr. A. D. Michael.

May 28. "On Diatom Structure," by Mr. Morland.
Ditto, by Mr. Deby.

July 23. "On some New Diatoms from New Zealand," Part I., by Messrs. Grove and Sturt.

Sept. 24. "On the Kola Bean," by Mr. H. Epps.

Oct. 22. "On Zoothamnium arbuscula," by Mr. Spencer.

Nov. 26. "On some New Diatoms from New Zealand," Part II., by Messrs. Grove and Sturt.

A series of the new Apochromatic objectives, made by Zeiss, of Jena, was also exhibited at the October meeting by Mr. T. Curties.

Some interesting informal communications on various matters were given by the President, Prof. C. Stewart, Mr. Buffham, and others, which will be found in the Proceedings.

Your Committee, however, desire to impress upon all members the importance of bringing forward subjects—not necessarily new—for discussion; many facts and matters of individual experience would thereby become known, and much of the original intention of the Club fulfilled.

The "Demonstrations" previously given on some of the conversational evenings were intermitted in deference to a generally expressed opinion that several of the series were better suited to the business of the ordinary meetings. It is to be hoped, therefore, that similar material will be forthcoming in the shape of papers.

Subjoined is a list of the additions to the Library, acquired either by purchase or presented since the last Report:—

	Presented by
Dr. Wythe's "Microscopist," 4th Edition ...	The Author.
Pritchard's "Microscopic Objects"	Mr. F. Crisp.
Martin's "Experimental Philosophy"	"
"Quekett on the Microscope" (in German) ...	"
"Transactions of the Linnean Society"	"
"Rainey on the Formation of Shell, &c."	Mr. F. H. P. Hind.
Dr. Braithwaite's "British Moss Flora," Part 9...	The Author.
"Science Gossip"	The Publishers.
"Journal of the Royal Microscopical Society ...	The Society.
"Proceedings of the Royal Society"	"
"Challenger Reports," Vols. 12-16	Purchased.
Dr. Hudson's "Rotifera"	"
Dr. Cooke's "British Desmids," Parts 1-8 ...	"
Teall's "British Petrography," Parts 1-10 ...	"

Poulson's "Botanical Micro Chemistry" ...	...	Purchased.
Piaget's "Les Pédiculines," Supplement ...	...	"
"Quarterly Journal of Microscopical Science"	...	"
"Annals and Magazine of Natural History"	...	"
"Grevillea"	...	"
"American Naturalist"	...	In Exchange.
"American Monthly Microscopical Journal"	...	"
"Journal of Microscopy"	...	"
"Scientific Enquirer"	...	"
Buckler's "Larvæ of British Butterflies and Moths," Vol. 1		By Subscription Ray Society.
Transactions and Proceedings of various Societies and Sundry Pamphlets ...		Presented.

A supplemental list of books recently added, or a completely revised Catalogue of all the works in possession of the Club, is intended to be issued during the present year.

The following slides have been presented to the Cabinet:—

Mr. G. C. Karop	1
" H. Morland	2
" Smithson	2
" B. W. Priest	2
" C. Collins	6
" E. Carr	2
Total	15

It having been represented that the date of the Annual General Meeting in July was an inconvenient one to a large number of members, notice was given at the ordinary meeting, in February, that the next succeeding meeting, in March, would be made special, according to Rule XII, and a proposition to alter the date submitted to the vote. A slip, convening a Special General Meeting for this purpose, was therefore sent to each member, and, after a full discussion, a proposal to alter the date of the Annual General Meeting from July to February was carried by a large majority. It was also decided to postpone the next General Meeting until the fourth Friday in February, 1887.

The Excursions during the past season were well attended, and more than usually prolific; lists of the "finds" will be found both in the Journal and in the Excursions portfolio.

The Excursionists' Annual Dinner was held at Leatherhead, on June 24th, Dr. Braithwaite, F.L.S., in the chair. The

arrangements, under the direction of the Sub-Committee, gave, as usual, every satisfaction, and the day being fine, was greatly enjoyed by those attending.

It is proposed for the future to hold the Annual Winter Dinner on the Saturday following the Annual General Meeting in February. The Committee believe that this will be convenient both to town and country members, and it will certainly facilitate the arrangements of the Dinner Sub-Committee.

Permission to hold the meetings at University College has again been granted by the Council, with their accustomed liberality and courtesy.

The thanks of the Committee are due to the several officers for their services in managing the affairs of the Club, and in conclusion they feel assured that the forthcoming year will prove no less successful and productive than any which have preceded it.

TREASURER'S STATEMENT OF ACCOUNTS.

DR.

		£	s.	d.
To	Balance in hand, July 1st, 1885	77	7	10
	Subscriptions since received	323	0	0
	Dividends on Moneys Invested	6	9	3
	Sale of Journal	13	18	7
		£420	15	8

CR.

		£	s.	d.
By	Postage and Carriage	11	6	6
	Printing and Stationery	10	2	3
	Attendance, Lighting, and College Expenses ...	25	18	6
	Petty Expenses	4	19	6
	Purchase of Property	40	4	7
	Journal Account	195	15	9
	Demonstration Expenses	1	15	0
	Balance	130	13	7
		£420	15	8

Amount invested in New Three Per Cent. Annuities, £140.

We, the undersigned, having examined the above statement of Income and Expenditure, and the Vouchers relating thereto, hereby certify the same to be correct.

WM. HAINWORTH,
F. H. P. HIND, } Auditors.

Feb. 21st, 1887

On the Calcarea.

By B. W. Priest.

(*Read March 25th, 1887.*)

It is with some hesitation I bring this paper before you, for two reasons, first, because you might perhaps think that I can talk only of that one absorbing subject, Sponge, which by-the-bye, has taken naturalists some years to squeeze much information out of, and, secondly, in dealing with this group, the *Calcarea*, I cannot avoid bringing, on the one hand a little that must be to a certain extent elementary, and on the other hand I am afraid, parts that may seem a little technical and dry. It is rather a difficult matter to collect all the information one would wish, and bring it into a small compass.

If I have not done the subject justice in the little time that I have at my disposal, I must ask your indulgence for all shortcomings.

The *Calcarea*, or *Calcispongia*, are so named in contradistinction to the *Keratosa* and *Silicea*, on account of their spicules being composed of carbonate of lime.

They take the forms of tri-radiates, quadri-radiates, and accrate spicules, the tri-radiate being the most characteristic.

They occur separately immersed and distributed in the soft tissues of the Sponge, never collected into fibres or found anastomosed to form a regular network, as is the case with some of the siliceous sponges. In consequence of this, after dissolution of the organism, the spicules fall apart, and being more or less soluble in sea water, made it doubtful for some time of their being preserved in the fossil state.

Of the 137 species described by Hæckel, 18 have the spicules exclusively tri-radiate; 44 tri-radiate and quadri-radiate; 61 tri-radiate, quadri-radiate, and acerate; 8 composed exclusively of quadri-radiates, and only six species have exclusively acerate spicules.

The number of species belonging to this group are few, compared with the Keratosa and Silicea, but we keep gradually adding fresh specimens year by year, for out of the thirty species dredged by the *Challenger*, twenty-three were new to science, and within the last twelve months Mr. Carter has described several new ones from South Australia.

The late Dr. Bowerbank enumerates only 12 species in his Monograph on the British Sponges; eight new forms may now be added to these.

The *Calcarea* are properly littoral, growing on or hanging from rocks, seaweeds, corallines, &c., between tide marks, and often being found in the pools left behind by the tide on our coasts.

In 1828 the Rev. Dr. Flemming placed all the *Calcarea* then known under one heading, viz., *Grantia*, in compliment to Dr. Grant for the services he had done in working out the physiology of the group. But as time went on it became necessary to alter the classification by degrees, as fresh knowledge was acquired, until it has reached the present stage.

I will not trouble you by going over the various systems, but state at once how the *Calcarea* stand as a group from the latest investigations. I may find it still necessary, perhaps, to retain familiar names, with regard to the description of species, as time will not allow me to do more than describe one species in each family, and that I shall have to condense into as small a space as possible.

The *Calcarea*, then, are now classed by the peculiarities of their canal system, the early development of the mesoderm, the fact of the mesoderm giving origin to the generative products, and, as asserted by some naturalists, the absence of nervous elements, although what a certain structure met with in the examination of the sponges can be, but a nervous cell development in a rudimentary state or otherwise, I cannot well see.

According to Dr. Poléjaeff, they form an isolated group within the sub-type of an independent subdivision of the *Cœlenterata*, and are divided into two Orders, *Homocœla* and *Heterocœla*, including the Family *Asconidæ* of Hæckel, only in the former, and the two Families *Syconidæ* and *Leuconidæ* (Hæckel), in the latter, with the establishment of a third comparatively new Family, *Teichonidæ*, of Carter.

The *Asconidæ*, from the Greek Ασκον, a flask or leathern

bottle, comprises at present only one genus, *Leucosolenia*, of Bowerbank, the knowledge of this Family being very imperfect in comparison with the other three, and also being the simplest form of Calcareous Sponge, whose walls are pierced by simple canals, the Sponges themselves forming simple sacs, with a completely flagellated endoderm, or inner membrane, the walls being composed of ectoderm, mesoderm, and endoderm, the formation of which we shall see further on when treating briefly with the embryology of the subject. This Family may be simple, branched, or united into a common stock, *Leucosolenia botryoides*; (Bk.), belonging to it.

The *Syconidæ*, from the Greek Συκον, a fig, sponges of this family formerly being likened to the shape of that fruit, comprises six genera, *Sycon* (Nissa), *Grantia* (Fleming), *Ute* (O. Schmidt), *Amphoriscus* (Hæckel), and the two new genera *Heteropegma* and *Anamixilla* (Poléjaeff). The Sponges of this Family are mostly solitary, with thick walls, which are pierced by straight radial tubes, the latter in some species projecting on the surface as conical prominences, *Grantia compressa* and *ciliata* (Bk.) belonging to this Family.

The *Leuconidæ* (from Λευκος, white) comprises the following genera:—*Leucilla* and *Leucetta* (of Hæckel), *Leuconia* (Bk.), and the new one, *Pericharax* (of Poléjaeff). These sponges have thick walls, which are pierced by branched channels, and remind one more of the complicated water canal systems to be found in the non-Calcareous sponges, *Leuconia nivea* (Bk.) belonging to this Family.

The *Teiconidæ* (*Teichonia*, Carter) contains two genera, both, the latter especially, being comparatively new, viz., *Teichonella* (Carter) and *Eilhardia* (Poléjaeff).

The Sponges are peculiar in that the differentiation of the outer surface is divided into two quite different parts, that bearing oscula and that bearing pores.

In 1878 Mr. Carter described and figured a species from Australia, *Teichonella prolifera*, a specimen of which was also dredged at Bognor by the Rev. Henry Fase, I think in 1880, which he kindly gave to me along with others. I have not heard of its being found before or since on our shores.

As I mentioned just now, the walls of the Calcareous Sponges are composed of three layers, the ectoderm, mesoderm, and endoderm. The ectoderm, or outer membrane, is composed of flattened

polygonal epithelium cells, which cover the whole exterior of the sponge, and line more or less the incurrent canals, the margins of the cells being invisible, until treated with nitrate of silver. The pores which appear on the surface are the inhalent openings, and are in reality only intercellular spaces, which close themselves, vanish, and are replaced by new pores, which arise by the separation of one cell from another.

The endoderm, or inner membrane, consists of elongated cylindrical flagellated cells, possessing at their free ends a flagellum, surrounded by a delicate hyaline marginal membrane, which is derived from a prolongation of the hyaline plasma, projecting as a hollow cylinder, resembling the protoplasmic collar of certain Flagellata, which structure is commonly known as the collar, and the cells as collared cells. It was from the presence of these flagellated cells that the late Professor Clark, with some other naturalists, thought that the sponges were allied to the Flagellata, regarding them as great colonies of the same. These cells, no doubt, play the part of propelling the currents of water through the different channels, and likewise take up some of the nutriment beneficial to the sustenance of the sponge.

The mesoderm lies between the ectoderm and the endoderm, and is probably derived from the former. It consists of a clear, jelly-like matrix, in which are to be found irregularly branched or spindle-shaped amæboid cells. It is in this layer we find the spicules and reproductive products take their origin. The ova are naked amæboid cells, taking *their* origin from the cells of the mesoderm, and, as far as the *Syconidæ* are concerned, are viviparous, remaining in the mesoderm and there undergoing development; it is very probable that the same occurs throughout the *Calcarea*. The ova, after going through the usual segmentation, first dividing in two, then four, and next eight cells, by further subdivision gives rise to a solid cluster of cells, called *morula*, the cells forming a single layer about a central cavity (blastula), which normally is completely closed, but in some instances is known to be open at the poles.

In the next stage of the *Calcarea* an amphiblastula is formed, which consists of a hollow sphere, one hemisphere formed of a single layer of small, transparent, cylindrical, flagellated cells (epiblast), the others of large, granular, rounded, and not flagellated cells (hypoblast). It results from a metamorphosis of the

blastula, the cells of which are partly converted into flagellated cells, while a few at the base become granular, and produce the larger rounded cells. It has now become a free swimming larva, and passes from the parent sponge by the canals and out at the oscula. After some little time the flagellated cells become gradually withdrawn or invaginated into the hemisphere of granular cells; the central cavity of the amphiblastula is obliterated, and replaced by another, surrounded by the flagellated cells. The larva or embryo now consists of a sac, with a two-layered wall, and a central cavity communicating with a mouth. After a while it settles down on some foreign object, the outer granular cells become the ectoderm, with its usual characters, the inner flagellated cells, the endoderm, and the mesodermic layer appears between the two. The embryo now lengthens, pores appear in its sides, and an osculum opens at the free end, the original opening having become closed soon after the attachment of the larva. The spicules now develop in the mesoderm, and it is a curious fact that they have been seen in the embryo before leaving the parent, in some cases.

As before stated, the *Asconidæ* are the simplest forms of the calcareous sponges having a continuous flagellated endoderm, *Leucosolenia botryoides* being an example of this Family, and often found on our coasts. Some very fine specimens were collected at the Whitstable excursion of this Club last year (1886). It is found parasitical on Algæ and Zoophytes, and in general appearance is arborescent, cylindrical, slightly pedicelled; surface apparently smooth, cloaca very large, armed internally with spiculated equi-angular tri-radiate spicules; spicular ray large and long, slightly curved; mouths of cloaca one or more, terminal simple, and unarmed. Oscula and pores inconspicuous, spicules of skeleton equi-angular, tri-radiate; radii somewhat short and stout, rapidly attenuating. Occurring, as this sponge does, in tufts, it might at first sight be thought to be one complex sponge, but on careful examination it will be found to be composed of numerous individuals clustered together.

The *Syconidæ* come next in order, having their walls pierced by radial tubes, which tubes are lined by the flagellated collared cells, and are only invaginations of the gastric wall, the latter thus being covered with the pavement epithelium only, as occurs in the ectoderm.

Grantia ciliata belongs to this Family, and is certainly one of the prettiest as well as interesting forms of the *Calcarea* found on our coast. It is parasitical on Algæ, Zoophytes, &c., and likewise dredged from eight to ten fathoms. It varies in size, the largest that has been found being about three inches in length. The sponge elongately oval, sometimes globular, slightly pedicelled; surface papillated, hispid. Cloaca central, cylindrical, nearly as long as the sponge; armed internally with spiculated, equi-angular, tri-radiate spicules; spicular ray attenuated. Mouth of the cloaca armed with a thick ciliary fringe of very long and slender acerate spicules; base of the fringe supported by large, short and stout fusiform acerate spicules. Oscula simple, very slightly depressed from the surface of the cloaca. Pores inconspicuous. Interstitial cells, distal terminations more or less obtusely conical, furnished with a ciliary fringe of slender acerate spicules. Skeleton spicules equi-angular tri-radiate. Besides the spicular defences of the mouth of the cloaca, there is often a membrane found at the base of the neck of the cloacal orifice, forming a sort of diaphragm. It appears probable that besides being able to close the mouth of the cloaca by the approximation of the distal termination of the ciliary spicules, it has also the power of completely closing it by the extension of a veiling membrane or diaphragm. In the same way the pores of the sponge are protected and hidden by similar ciliary spicules, the mechanism of which is simple and interesting. In the process of inhalation of water and distension of the distal extremity of the interstitial cell, the cone of spicules is expanded into a cylinder, causing the access of nutritive particles to the pores. When the action ceases a collapse of the cell ensues, and the distal points of the spicules again approach each other, thus stopping anything from entering the pores.

We now come to the Leucones, which are modifications of the Sycones, their flagellated chambers being complete homologues of the radial tubes; their exhalent canals owing their origin to the invaginations of the inner cavity, and their inhalent canals regarded as homologous with the inter-canals of the Sycones, so that these families approach nearer to the same type than in the majority of sponges.

Leuconia nivea, being an example of this Family, may often be met with, appearing as white crusts on the under surface of rocks

between tide marks on our coasts. It is sessile, massive, or coating; surface lobular or crested, smooth. Cloacæ numerous, mouths simple, armed internally with very large and stout equiangular spiculated tri-radiate spicules, radii attenuated.

Membrane of cloaca furnished abundantly with unicurvo-cruciform spicules. Oscula numerous, simple, dispersed over the surfaces of the cloacæ. Pores minute. Spicules of the skeleton equiangular tri-radiate, very variable in size and stoutness. Spicules of interstitial and dermal membrane small, acerate, and minute attenuato-spiculated tri-radiate spicules; spicular ray short, basal rays tri-podate. This species never attains to any great size, the largest I have seen being one sent to me by my friend Mr. Hillier, of Ramsgate, and dredged off that coast; it measures two inches by one and a quarter.

I now come to the third and last Family included in the order *Heterocœla*, viz., the *Teichonidæ* of Carter.

I shall take Mr. Carter's description of *Teichonella prolifera* as the example. This species simply consists of parenchymatous structure, traversed by excretory canal systems, which, beginning by small branches in the interior, terminate respectively by open naked mouths at the surface, supported on a staple mass of small radiates, accompanied more or less plentifully by very large ones, which, from their much greater size, are rendered very conspicuous. Thus we have no longer any cortical differentiation on the surface, nor any cloacal cavity interiorly, but so far simplified structure that it becomes identical with that of the common run of non-calcareous sponges.

In general appearance it is vallate, foliate, vertical, plicate, proliferous. Pores invisible to the unassisted eye, scattered over the surface thickly and generally. Vents slightly marginated, naked, arranged more or less in single line along the margin only. Spicules of two forms, tri-radiate and quadri-radiate, both of two sizes.

Mr. Carter, in his first description of this Family, included a second species, viz., *Teichonella labyrinthica*, with the one just described; but on examining specimens of the same in the collection sent to him by Mr. Wilson, of South Australia, he finds it necessary to relegate it to the vicinity of *Grantia compressa*, still retaining the specific name.

I have now described as briefly as I could four of the species

comprised in the two orders *Homocœla* and *Heterocœla*. The three first mentioned being frequently met with on our own shores, and often found growing together, will give anyone interested in the subject plenty of opportunities for studying their histology.

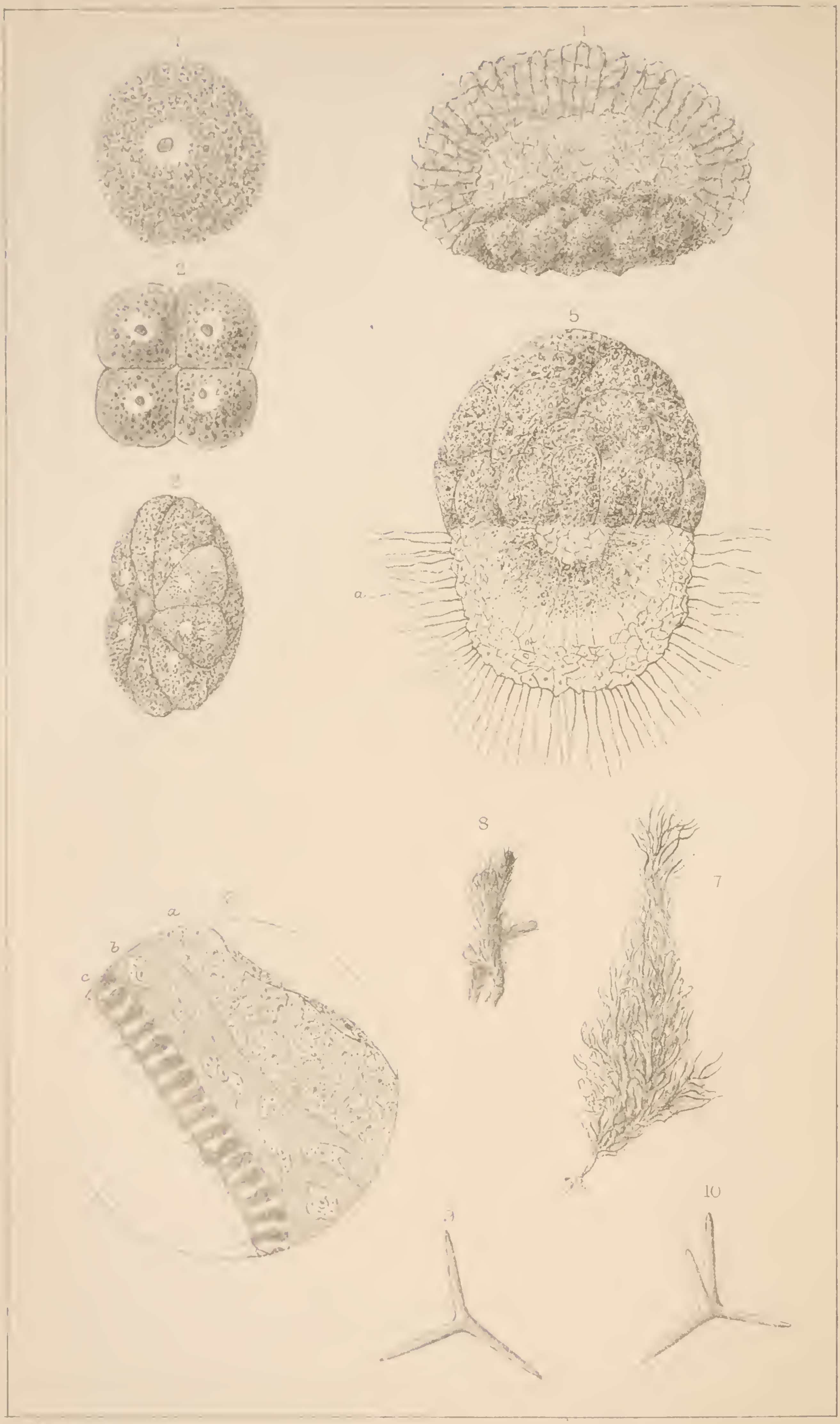
In preserving and mounting in the dry state the *Calcarea*, or portions of the same, small specimens can be selected and mounted in Canada Balsam in glass cells, fixed to the slip with marine glue, and also vertical sections done in the same way. To preserve the spicules of the different species apart from the sponge, heat portions in liquor potassæ, when they will soon separate and fall to the bottom of the vessel, washing well with distilled water and mounting in Canada Balsam. Do not attempt to mount in glycerine, as, being calcareous, they will be sure in time to dissolve away.

For examining the soft structures of these sponges, put them straight from the sea-water into a one-per-cent. solution of osmic acid, when, on cutting sections tolerably thin, the collared cells, with their flagellæ expanded, will remain intact, and other structures, which would otherwise be shrivelled up and lost, can be tolerably well made out with high powers.

To those who would wish to go further into the histology of the subject, I would recommend them to consult Haeckel's "Monograph of the Calcareous Sponges," Dr. Bowerbank's monograph of the same, and Dr. Poléjaeff's "Report on the Calcarea of the *Challenger* Expedition," to which may be added Mr. Carter's account of the same from South Australia in the "Annals of Natural History" for 1886.

The following is a list of Calcareous Sponges found on the British Coast:—

Leucosolenia botryoides (Bk.).
Leucosolenia contorta (Bk.).
Leucosolenia coriacea (Bk.).
Leucosolenia lacunosa (Bk.).
Leucosolenia lacunosa, var. *Hillierii* (Carter).
Ascaltis Darwinii (Hæckel).
Clathrina clathrus (Gray).
Grantia compressa (Fleming).
Grantia ciliata (Fleming).
Grantia ensata (Bk.).
Grantia tessellata (Bk.).



A.M. [illegible] del.   West Newman & Co. lith.

A M Priest del. West, Newman & Co. lith

Grantia ciliata, var *spinispicula* (Carter).
Aphroceras ramosa (Carter).
Leuconia nivea (Bk.).
Leuconia fistulosa (Bk.).
Leuconia pumila (Bk.).
Leuconia Johnstonii (Carter).
Leucogypsia Gossei (Bk.).
Teichonella prolifera (Carter).
Trichogypsia villosa (Carter).

EXPLANATION OF THE PLATES.

Plate VII.

Fig. 1. Mature ovum of sponge.
„ 2-3. The same in process of segmentation.
„ 4. Blastosphere, with dark granular cells.
„ 5. Free swimming larva with endodermal ciliated cells, and ectodermal granular cells.
„ 6. Diagram, showing position of *a*, ectoderm; *b*, mesoderm; *c*, endoderm in wall of sponge.
„ 7. Group of *Leucosolenia botryoides*, Bk., on weed.
„ 8. A small portion of the sponge enlarged.
„ 9-10. Spicules of the same.

Plate VIII.

Fig. 1. Group of *Grantia ciliata*, Bk.
„ 2. A large variety of the same.
„ 3. Vertical section of *Grantia ciliata* showing the position of the radial tubes.
„ 4 to 10. Spicules of the same.
„ 11. *Leuconia nivea*, Bk., encrusting rock, natural size.
„ 12. Section of the same, showing ampullaceous sacs, with collared cells *in situ*, drawn from specimen.
„ 13 to 18. Spicules of the same.
„ 19. *Teichonella prolifera*, Carter. Upper view showing margin of lamina and vents.
„ 20. The same, lateral view of vertical section showing excretory canal systems and vents. (Carter).
„ 21-22. The two spicules of the same.

On Mounting Media so far as they Relate to Diatoms.

By H. Morland.

(*Read April 22nd, 1887.*)

The object of my paper this evening is not only to give some information and to offer some hints relative to the various media in which the Diatomaceæ are mounted, but also to solicit such information and hints in return from those members who have paid special attention to this subject. I have myself worked at several of the media to which I shall refer, but others have never yet come into my hands; but having seen slides prepared with them, added to remarks I have heard made relative thereto, I venture to treat this subject as a whole. With this explanation, it can be readily understood that this paper is by no means exhaustive of the subject taken in hand.

Mounting media, for convenience sake, may be divided into four classes, viz., Air, Fluids, Resins, and Chemicals. I will treat of these classes in the order in which I have named them.

Air.—This medium, in consequence of the introduction of immersion lenses, is now almost out of date; still, for ordinary dry lenses, it is as useful now as ever it was, and even for immersion lenses it answers for those parts of the diatom valve which touch or are adherent to the covering-glass. Diatoms mounted in this medium (or in any other) should, as a rule, be on the underside of the covering-glass. They should be perfectly dry, and the system of sealing them up by means of damp cements cannot be too strongly condemned, as in such case the cover-glasses are certain to get "dewed" in course of time, the "dew-drops" in many instances surrounding the diatoms, and interfering with their due examination; to overcome this difficulty, I always attach my covers by means of heat to rings of perfectly hard and dry cement on the slide. Slides with air-mounted diatoms ought to be carefully handled when being cleaned, for if too much pressure be applied to the

covering-glasses the same will yield to a slight extent, and the diatoms either get crushed between the slip and cover, or be transferred from the latter to the former.

Fluids.—Although certain of these media, such as biniodide of mercury with iodide of potassium, as well as oil of cassia, can be obtained with fairly high refractive indices, yet I cannot too emphatically condemn them for use with the higher powers of the microscope, simply from the fact that the diatoms will not remain on the cover-glass, but must necessarily fall to the bottom of the cell, which consequently must be very shallow, otherwise the diatoms will be beyond the focus of the objective. With shallow cells in fluid mounts the diatoms can easily get crushed on cleaning the cover-glasses. If it were not for these fatal objections, I should be disposed to regard oil of cassia very favourably as a mounting medium, as these essential oils give great brilliancy, but whether they can be effectually sealed for a permanency I cannot say. I once mounted a slide in oil of cloves, and it remained perfect for some considerable time, but eventually a bubble made its appearance. I have never seen a slide of diatoms mounted in biniodide of mercury and iodide of potassium, and am inclined to think that this medium is very little used.*

Resins.—This class of media is about the most generally used for mounting diatoms, and for ordinary mounts they will be found hard to beat; they differ somewhat from each other in their way of working, and in their refractive indices. In speaking of them I will take them *seriatim.*

Canada Balsam.—This is the oldest and most generally known of the resin media; it requires hardening by means of heat, and if not overdone there is still left a certain amount of toughness which enables the slide to withstand ordinary fair handling. The only objection to my mind against this medium is that its refractive index is not sufficiently high for the new immersion lenses, that is, for the finer kinds of diatoms; still, for the coarser kinds, say four out of five species at the very least, Canada balsam, taken all round, still remains as good as

* Since writing the above I have learnt, with respect to the solution of biniodide of mercury and iodide of potassium, that the medium is of such high specific gravity, viz. 3·02, that any diatoms which may chance to become detached will float in the fluid and press upwards against the covering-glass, instead of falling to the bottom of the cell.—[H. M.]

any other medium yet brought forward. Although balsam is comparatively colourless in its natural state, it gets to be a very deep yellow when hardened by means of heat; this colour is, however, scarcely noticeable when in a very thin layer under a covering-glass. If over-hardened, balsam becomes brittle, and the cover is easily detached by a blow or rough usage; on the other hand, if under-hardened, not only will the slide be too tender to handle, but the refractive index will be considerably lower than should be the case.

Styrax.—This is a medium about which a deal of misconception exists. As a matter of fact, no styrax, so far as I am aware, has yet been used as a mounting medium for diatoms or anything else; but I must explain. The true styrax is a product of *styrax officinale*, belonging to the order *Styraceæ.* It is a native of Greece, the Levant, and Asia Minor, and was the source of the original and classical storax. It has, however, now wholly disappeared from commerce, and I much doubt if it be obtainable in this country, its place, so far as our British Pharmacopæia is concerned, being now supplied by the product of *Liquidamber orientale*, belonging to a totally different order, viz., the Altingiaceæ. This substitute can be purchased at any chemist's. When getting it "strained styrax" or "styrax colat" must be asked for. It has a strong resemblance to very thick treacle, is full of fine dirt, and, I think I may add, of moisture also. There is yet another false styrax, sometimes called "American styrax," which is the product of "*Liquidamber styraciflua*" or "sweet gum," a tree found in the Southern States of America, mostly, I believe, in damp situations. This latter medium is not, however, obtainable in England, and it is only comparatively recently that I have been able to ascertain where it could be obtained in the States, as even in its native country it is difficult to get hold of. I shall be happy to give the address to anyone desiring the same. Like the other false styrax, this American styrax is also supplied in a rather dirty state. As the true styrax has no existence so far as we are concerned, I shall now speak of the other two media simply as "styrax" and "American styrax." Both the styraces, which were first introduced by Dr. H. van Heurck, of Antwerp, can be dissolved in either benzole or chloroform and afterwards filtered. They are apt to deposit a

fine sediment in the bottle some considerable time after filtration, which I consider to be due to the presence of moisture contracted during the process of obtaining these resins, the prepared media being what I believe is called in the varnish trade "chilled." If only in small quantity the heat applied during the process of mounting will drive it off again, but it is better either to pour off the upper clear portion into another bottle or to use a "capped balsam bottle" with a suspended glass rod for mounting, and which is never allowed to touch the bottom and stir up the sediment. Whilst on the subject of this sediment I may here state that I once had a small quantity of the ordinary styrax in a pot, which I placed in a cool oven and left there for some considerable time until it became perfectly hard. I then dissolved it with difficulty in alcohol, filtered it, evaporated nearly the whole of the alcohol off again, and thinned it down to a proper consistency with chloroform. Although very dark this styrax is as clear now as it was when first prepared, now over two years ago.

The ordinary styrax is somewhat difficult to harden. The best way of doing so is by a long continued heat, a considerable amount of which it will bear, but usually this styrax is not finished off hard, but merely tough, and I therefore always strengthen my mounts by the addition of a ring of cement to the covers. If the styrax be over-heated it becomes charred, and small specks of carbon can be seen disseminated through it when viewed under the microscope. Styrax is a very useful medium for the finer kinds of diatoms, which it shows up much clearer and brighter than balsam. Some forms, almost invisible in balsam, are shown up with great distinctness in styrax. For the coarser kinds of diatoms this medium is not really needed.

American styrax, unlike the other, hardens just like balsam, but when heated it becomes extremely fluid. Having a high refractive index it is particularly useful for the finer diatoms. On account of its fluidity when heated I should be inclined to confine the use of this medium to the smaller diatoms, lest the cover should, during the process of mounting, sink down on the larger forms and crush them.

Balsam of Tolu.—I have never had anything to do with this medium. I did once think of taking it in hand, but before doing so I referred to Watts' "Dictionary of Chemistry"

(belonging to a friend of mine), and as something was mentioned about crystallization I decided to leave it alone. Since then there have been complaints made about this objectionable property. On the other hand some microscopists continue to use it, and seem satisfied with it.

Gum Dammar has also been used as a mounting medium; it requires dissolving in some solvent, such as benzole; its advantages are that it is colourless and dries quickly; its disadvantage is that when quite hard it is about as friable as chalk. I consider its proper place is in the preparation of "ringing" cements to which it gives a nice gloss.

A number of other resins have also been tried, but I don't know that any of them have shown any advantages over Canada balsam or styrax, and I am unable to report upon any of them.

Although slides of diatoms mounted in any of the resins will stand fair treatment, they will not bear any amount of *rough* handling. It must not be forgotten that diatom valves are composed of silex, a brittle substance; if, therefore, the balsam, styrax, or other medium be tough, and the cover glass be rubbed or wiped somewhat roughly, the medium will yield to a slight extent, but not so the diatom valves, which consequently will get cracked, though the fragments will continue to be held in position by the medium in which they are mounted. Balsam slides may be perfectly hard at the edges of the covering glass, but only tough in the centre part; if such slides be left to themselves for a few days in a cool place, the density of the balsam will become a little more homogeneous in consequence of the diffusion of the residual solvent in the centre part throughout the mass, though the outer portion will always remain a little harder than in the centre, as the solvent gets dried up almost as soon as it reaches the circumference.

Chemicals.—The sole object of using chemicals as mounting media, is to obtain a higher refractive index than is afforded by the resins; unless such refractive index can be obtained they have no *raison d'être.* So far as my experience of them goes, they are either difficult to manipulate or they cannot be relied upon for permanency, with, perhaps, the single exception of monobromide of naphthaline, which, however, I do not consider to be any advance upon styrax, as diatoms mounted in this medium do not exhibit anything like the brilliancy given them

by styrax. I should be disposed to give the palm to phosphorus, it having an extremely high refractive index. I have never worked at it myself, but from all accounts it is very difficult of manipulation; it requires being dissolved in bisulphide of carbon, but no more of this must be used than absolutely necessary, as otherwise the high refractive index is considerably reduced. Complaints have been made about phosphorus slides not being permanent, but, on the other hand, I believe that Mr. Stephenson, who first made use of this medium, has perfect phosphorus slides in his possession which have been mounted for some years past. Prof. H. L. Smith's and Dr. S. Meate's media are both of the same class, having the elements of sulphur, arsenic, and bromine in each; slides newly-mounted in these media are superb, but from what I have heard, and from my own experience of Dr. Meate's compound, I should say that neither of them is to be relied upon; sooner or later a granulation sets in, and it is only a question of how long it will be before the whole of the mount is thus disfigured. I believe that some microscopists may be found who may be disposed to think that some slides mounted in Dr. Meate's medium may prove permanent, to which I answer that the large number of failures is more than a sufficient reply; a medium is not to be depended upon unless you can rely upon having a larger proportion of permanent slides than, say, one out of a dozen mounts. It has struck me that possibly the non-permanency of these two media is due to the evaporation of the bromine, and that if a proper cement were found for confining the same, they could then be used with every confidence in their efficiency.

Prof. H. L. Smith has also introduced two other chemical media with high refractive indices, but lower than those just referred to. Of one, called "Stannous Chloride Medium," I know little or nothing, and am unable to say whether it has proved permanent or not; the other medium, a preparation of antimony bromide and boro-glyceride, is in my hands, as well as in those of a correspondent of mine in America, a distinct failure; at first, all was superb, but after a short time crystals began to make their appearance and gradually spread all over the mount, completely spoiling it.

I have seen an account of another chemical medium, viz., sulphur in aniline, and thought I would try my hand on same,

but, to my astonishment, on trying to dissolve the sulphur in the aniline I found it to be insoluble, though a friend of mine, a chemist, tells me that sulphur dissolves freely in aniline. Under these circumstances I am unable to give any opinion on this medium, further than that if the solution can be prepared and permanently sealed on a slide it ought to be satisfactory so far as regards the refractive index, but has the objection of being a fluid.

A medium of high refractive index is certainly a desideratum, but it must be permanent, and if one could be discovered which could be prepared and manipulated by any microscopist not having special knowledge of chemistry, why so much the better. On the other hand, it is a comfort to the ordinary run of diatomists to know that there are really only few diatoms that absolutely require such high refractive media.

Extract from a Monograph, "Zur Kenntniss der Phycomyceten."

By Dr. W. Zopf, in the "Nova Acta Acad. Caesar. Leopold. Carolin. Germ. Nat. Cur." Halle, Bd. XLVII., No. 4.

Translated with the sanction of the Academy by George C. Karop, M.R.C.S., F.R.M.S.

(Read April 22nd, 1887.)

Ectrogella Bacillariacearum,* Zopf. An Endophyte infesting the Diatomaceæ.

The author begins by stating that most observers of the Diatomaceæ are aware that this family of the Algæ has enemies among the Fungi and Mycetozoa. They belong partly to the group of Monadines, partly to the Chytridiaceæ and Ancylisteæ.

He quotes Cienkowski's investigations on *Vampyrella vorax*, which low Myxomycete preys upon Diatoms of all species. Also Braun and Nowakowski, the former of whom discovered the parasitism of *Chytridium Lagenula* on Melosireæ, and the latter found a form of the same parasitic on *Epithemia Zebra*. In these however, the sporangia are developed externally to the host.

Purely endophytic Diatom parasites were subsequently observed by Focke, and again by Pfitzer.

Having thus shown that a small series of Diatom parasites is already known, the complete life-histories of which however are still wanting, the present author proceeds to a description of a new and fatal enemy of the Diatomaceæ, which also possesses some special morphological features.

He says: I found the *Ectrogella Bacillariacearum* in a large-celled *Synedra*, growing on the rootlets of Lemna minor, in stagnant water. About the middle of November it occurred in such numbers that 75 per cent. of the host-plants from this particular locality, near Berlin, were attacked by the parasite. In

* From εκτρωγειν = to eat up or devour.

subsequent cultivations made in large vessels at the ordinary room-temperature, hardly a single non-infected specimen could be found after some time, proving that even the above high percentage might be exceeded. This is explained by the immense fertility of the fungus in zoospore production. The disease runs an absolutely fatal course. As regards other species of Bacillaria being affected by the parasite, I was enabled to confirm the fact so far that in each culture a species of straight *Synedra*, also the curved *S. lunularis*, a *Gomphonema*, and a large *Pinnularia* were attacked. Nevertheless, the fungus appeared to prefer the *Synedræ*, particularly the larger forms with rich contents, as well as large *Pinnulariæ*. At any rate, it was only found in a few of the relatively small *Gomphonemas*.

The development was uninterruptedly followed out, as far at least as the formation of swarm-spores.

It appears to be a special characteristic of these Olpidieæ that, under favourable conditions of nutrition, their vegetative portion forms a sac which attains a relatively considerable length. I have frequently observed individuals whose mycelial sacs extended to nearly the entire length of the largest forms of the *Synedræ* under consideration, that is to say, 200 μ or more. Such like sacs, in the form of thick vermiform threads, so strikingly resemble the mycelial stages of many Ancylisteæ (particularly Pfitzer's *A. Closterii*, as well as many forms of *Lagenidium Rabenhorstii*), that at first, before knowing their development, I was inclined to regard them as the receptacles of these fungi. They are always unbranched, probably for the reason that their relative thickness, as compared with the lumen of the host-cell, allows of too little space for the development of lateral axes. Under unfavourable conditions of nutrition, mostly due to more than one parasite occupying the same foster plant, the mycelial sacs are much curtailed in length, occasionally becoming reduced indeed to quite short, spindle-ellipsoidal, or even spherical bodies often of extreme minuteness. The latter mostly occurs when the parasites invade a *Synedra* whose contents have already been more or less consumed by one or several larger individuals, or when they develop in great numbers in the host-cell.

For instance, in the rich material at my disposal I often met with *Synedræ* in which 20 to 30 were present, yet which at first only occupied a part of the foster-cell. That these truly dwarf-

like forms, in comparison with the fully-developed plants, were really Ectrogellæ, and did not, as might easily have been supposed, belong to another parasite, was proved by the existence of all possible intermediate grades, and will also be put beyond all doubt by the subsequent details of the development. I shall at the same time show that, singularly enough, these colonies of minute forms did not reach the interior of the host-cell by migrating through its investing membrane. As already mentioned, the shape of the freely-developed sac is vermiform ; where room is wanting however, the configuration of the individuals is influenced by conditions of mutual pressure. For instance, the ends of two or more opposed individuals are frequently tapered off by their forcing their way like wedges between the walls of the host and a neighbouring parasite, and this tapering is met with sometimes at one, and sometimes at both poles. The contents of the receptacles at first appear finely-granular, later on it is pervaded by great numbers of closely-packed coarser and highly-refracting corpuscles, so that the sacs form easily-seen objects. One may also frequently observe the formation of vacuoles, which often attain to considerable dimensions. This is not the case, however, in the more robust and lusty individuals, and appears to indicate an abnormal condition of the contents.

In consequence of its great delicacy no membrane is apparent at first sight. It may be easily demonstrated however by means of staining.

From the Ancylistic-like condition of the mycelial receptacles, at least in their largest forms, one might expect them to become segmented by partition walls at the beginning of fructification, but this does not occur. Even the longest mycelial sacs form only a single receptacle. The plasma collects after the well-known fashion round the numerous nuclei to form an equal number of swarm-spores. These latter are extremely minute, usually from two to three μ in diameter, rarely more ; they exhibit feeble amœboid movements, and are provided with a somewhat highly refractive tiny nucleus and a distinct cilium. They escape by excretory ducts, which are, as a rule, already visible as short papillæ before the commencement of swarm-spore formation, and which, later on, open by mucous degeneration of their apices.

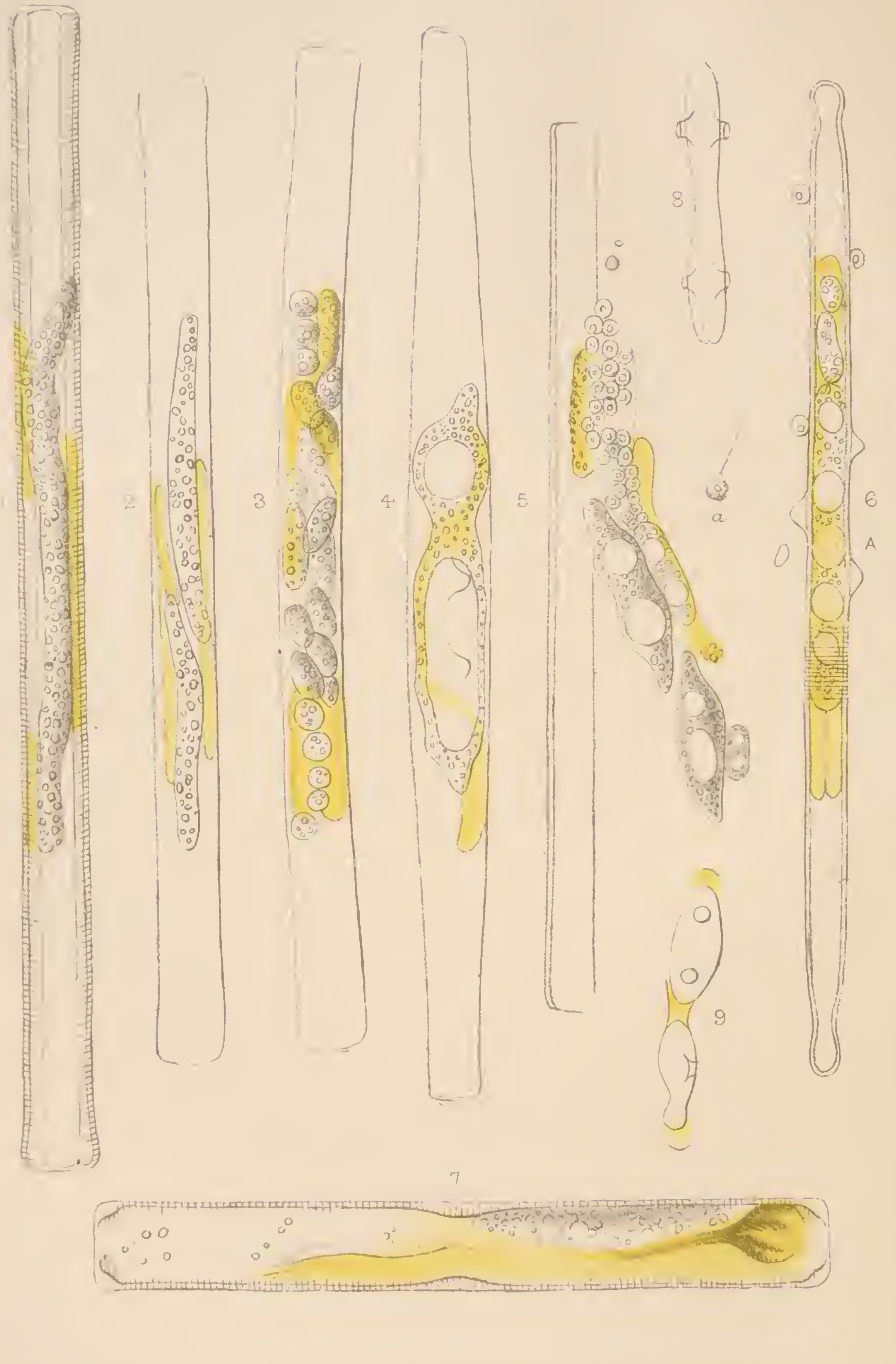
The fact of many excretory ducts being formed in the larger sporangia is particularly characteristic of *Ectrogella* (I have counted

as many as 10). The medium-sized usually possess from three to five, sometimes only two, whilst in the smallest one to two at the most occur. Their position is a fixed one, inasmuch as it always corresponds to the girdle-band (front) view of the diatom cell. Sometimes they are arranged in a single, sometimes in a double, row. In the latter case one row corresponds to the anterior, the other to the posterior surface of the girdle-band.

That this is the case is most readily understood by observing the valve-view of the *Synedra;* the excretory ducts will then be seen lying to the right and left.

Moreover, the excretory ducts are distinguished by the fact that they are of a much stouter texture as compared with the extremely delicate wall of the sporangium ; and, as is shown by the use of a solution of iodised zinc-chloride, they consist of cellulose.

It is further remarkable that the excretory ducts are not compelled to perforate the siliceous membrane. The pressure, namely, exerted by one or more parasites as they increase in girth, on the two valves of the host-cell, causes them to bend outwards, so that the *Synedra* now, in a girdle-band view, appears broadest in the middle ; finally, the frustule dehisces entirely. This process is completed before the excretory vesicles of the sporangia are ready to force themselves through the siliceous membrane (if they are able to do so at all)—indeed, often before the vesicles have arrived at maturity—so that any necessity for penetrating the membrane is avoided. Of course, it not infrequently happens that the sundering of the valves does not take place sufficiently early. But even in these cases the siliceous membrane is not perforated by the vesicles. The latter then either do not open at all (and this is not uncommon), or the swarm-spores are evacuated into the closed diatom cell. Instead, however, of these imprisoned zoospores perishing, as is the case in most of the Chytridiaceæ, they, provided of course the host-cell still contains a sufficiency of nutriment, grow to new parasites, having burst or crushed the degenerated sporangial membrane. These non-immigrated parasites, in consequence of their numbers and unfavourable food conditions, always remain in a correspondingly rudimentary condition, and either retain their spherical form or, at most, become ellipsoidal or spindle-shaped. They develop into sporangia. The fact that numerous rudimentary parasites may be present in the long sporangial sacs, loses its singularity when we are acquainted with



G.C. Karop del. after W. Zopf Nova Acta C.L.C.G. Nat. Cur. Vol. XLVII

West, Newman & Co. lith.

this method of swarm-spore development. The free condition of the zoospores is strikingly short. As soon as they escape they make for the nearest *Synedra* and fasten upon it ; too many as a rule, often 40 or more. The great increase of the fungus is sufficiently explained by their number and rapid development into sporangia, which is completed in from 24 to 48 hours.

The effect of the fungus on the host-plant is first manifested by an alteration in the shape and position of the chlorophyll bands. They recede from the walls, contract in direction of their length, and become closely applied to the parasites; in some instances they form curved strands or lumps. Simultaneously the nucleus is dissolved and the plasma contracted. Later on, in consequence of the pressure exercised by the parasites, the valves fall asunder.

As regards the systematic position of *Ectrogella*, it may be determined with certainty by the sporangial fructification. The form of the mycelial sacs undoubtedly coincides with that of the *Ancylisteæ;* nevertheless, as the entire vegetative part is transformed into a single sporangium, and the swarm-spores are spherical and uni-ciliate, it has a distinct affinity to the *Olpidieæ.* It stands to *Ancylistes*, as *Olpidiopsis* to *Myzocytium.*

EXPLANATION OF PLATE.

All figures magnified 300 diameters.

FIG. 1. *Synedra*, with a large and almost fully developed mycelial sac.
,, 2. *Synedra*, with two young mycelial sacs.
,, 3. *Synedra*, with numerous nearly mature small parasites, of various size and shape.
,, 4. Stouter mycelial sac, constricted at its upper third and tapered at both poles. It contains two vacuoles. At O is seen the papilliform rudiments of two excretory pores. The valves of the *Synedra* are slightly driven outwards by the expansion of the parasite.
,, 5. *Synedra*, with one valve separated. The five sporangia are free, and exhibit various stages of development. At A, the spores are already mature.
,, 6. Valve view of a *Synedra*. One (A) of the sporangia shows the excretory papillæ O pushed past the separated girdle-band. A few *Ectrogella* spores have just fastened on the outer membrane. A, a single swarm-spore.
,, 7. Girdle-band view of a Pinnularia, with a nearly mature parasite.
,, 8. Empty sporangium, with the excretory pores arranged in two rows.
,. 9. Empty sporangia, the upper having two, the lower only one excretory pore.

On the Structure of the Head of the Blowfly Larva, and its Relations to that of the Perfect Insect.

By B. Thompson Lowne, F.R.C.S.Eng., F.L.S., &c., Professor of Biology at the Royal Veterinary College, &c., &c.

(Read June 24th, 1887.)

The larva of the blowfly is frequently described as acephalic or headless; more correctly it is without any chitinised cephalic shield (*Kieferkapsel*), for a head is certainly present although in many respects it is rudimentary.

In the egg, twelve hours after impregnation, the embryo possesses a head; in most respects similar to that of an embryo in which a chitinised head capsule is subsequently developed in the larva. At this period the head consists of the cephalic fold or forehead (*Vorderkopf*), a prolongation of the ventral formative band (*Keimwulst*) over the anterior pole of the yelk. The cephalic fold is separated from the ventral formative band by a depression or pit, the future stomodæum or involution from which the anterior part of the alimentary canal is developed. On either side of the cephalic fold a lobe-like plate is developed, connected with the ventral formative band by a narrow stalk. These are the procephalic lobes of Huxley, and form the lateral and posterior regions of the head. The antennæ are usually developed from bud-like projections of the procephalic lobes, but in flies the development of the antennæ takes place at a much later period, after the escape of the larva from the egg.

Behind the pouch from which the stomodæum is developed the ventral formative band undergoes segmentation. At first three segments are formed in the region of the future mouth, the thoracic and ventral segments being formed at a slightly later period. A bud-like projection then appears on each side of each of the three first-formed segments; the rudimentary mandibles and first and second maxillæ. Subsequently similar buds appear for the development of the thoracic limbs in those insects in which such appendages exist in the larva. In the fly, however, no

rudiments of these structures are developed in the embryonic stage. Comparative morphology teaches us that the mandibles and maxillæ are modified limbs, their manner of development being the same as that of normal limbs.

Much discussion has arisen with regard to the segmentation of the head in insects. Some regard it as consisting of five, others of six or more segments. In former days my mind was much exercised with this and similar problems, but embryology has shown me the futility of such discussions. There is a close analogy between this controversy and one, now almost forgotten, on the vertebral nature of the skull. Oken and Gœthe initiated the comparison of the pre- and post-oral structures in insects and crustaceans as well as the vertebral theory of the skull. Huxley long ago disposed of the latter question by showing that no initial segmentation precedes the formation of the skull as it does that of the vertebral column. The evidence of embryology is no less decisive, in insects and arthropods generally; as no segmentation occurs in the pre-oral region, and the head consists of an unsegmented pre-oral cap, developed from the cephalic fold, of two lateral procephalic lobes, and of three post-oral segments, with their three pairs of lateral appendages. From the latter the mandibles, maxillæ, and labium are developed. These are, therefore, in serial homology with the thoracic and abdominal feet. The antennæ, on the other hand, are developed from the non-segmented pre-oral region, and, like the eyes, have no homologies with limbs. A comparison between these structures and the post-oral appendages has no more basis in their developmental history than a comparison of the trabæculæ cranii with the ribs, or of the sense capsules of a vertebrate with its limbs.

Almost as soon as the embryonic structures above described are formed in the egg of the fly, the anterior pair of maxillæ exhibit a tendency to enlarge and become parallel to each other, whilst the rudiments of the mandibles and the segment which supports them, as well as those of the second pair of maxillæ, and the segment belonging to them, undergo retrograde changes.

These facts were observed and recorded long ago by Dr. Weismann.* Ultimately, as Weismann correctly states, the mandibles and the mandibular segment disappear. It is not so, however, with the posterior pair of maxillæ; these coalesce and form a small three-

* "Z. F. W. Z.," Bd. 13.

lobed labium; this and the ventral portion of the corresponding segment is very apparent in the larva, and remains apparent until the insect passes into the pupa stage.

Before the escape of the larva from the egg the first pair of maxillæ become parallel, and project beyond the head. The procephalic lobes disappear so far as the external structure of the embryo is concerned, they become the antennal and optic discs of Weismann, and, buried in the interior of the larva in relation with the cephalic nerve-centre, remain rudimentary until the approach of the change of the larva into the pupa. Lastly, the cephalic cap is reduced to a small triangular plate, which dips down between the maxillæ and terminates in a point in front of the mouth, in relation with the chitinised labrum. In the adult maggot the two cylindrical maxillæ are as recognizable as they are in the embryo, or the newly hatched larva. Each is segmented transversely, so that it consists of an ultimate and a basal portion, and exhibits an unmistakable identity with a portion of the typical maxillæ of such insects as the cockroach.

Such a typical maxilla consists of a basal joint, the cardo; a stalk, the stipes; a blade, the lacinia or mando; and a hood, the galea. The galea further consists of two joints which form a sheath over the lacinia. Lastly, a palpus, of two or more joints, is supported by the stipes.

I shall now proceed to show that the cylindrical organ, which I have for brevity hitherto spoken of as the maxilla, represents only a part of that organ, namely, the galea. Like the galea it consists of two joints, and like the galea it forms a sheath for the lacinia or mando.

A careful examination of the blowfly larva shows that the great lateral hooks lie in a cavity of the galea when retracted, exactly as the lacinia of a typical insect is enclosed in the galea. On the other hand the hooks are articulated with a distinct cardo, the H-shaped piece of Weismann. The other parts of the maxilla, the stipes and palpus, are, however, indistinguishable.

M. Menzbier * severely criticises certain statements which I formerly made in my work on the blowfly,† and I admit that in some measure I laid myself open to his strictures, for I mistook the great hooks for the mandibles. M. Menzbier speaks of these hooks as chitinised thickenings in the walls of the mouth, a less excus-

* "Bull. Soc. Imp. Nat. Moscow," T. 55.

† "Anatomy and Physiology of the Blowfly," London, 1870.

able mistake, as they have no relations with the walls of the mouth. M. Menzbier evidently thought that when retracted they lie in the mouth. Such is, however, not the case; they lie, as already stated, in distinct cavities in the galea of the maxillæ.

The basal joint of the galea of the larva fly exhibits a very remarkable structure. A series of radiating and dichotomously dividing groves extends from the lateral margins of the mouth, and covers a discoid area, occupying nearly the whole of the under surface of the basal joint of the galea behind and outside the sac, within which the hook lies. These tubes, although without rings, bear a strong resemblance to the pseudotracheæ of the proboscis. The whole structure forms a suctorial disc, and is at least analogous to the suctorial disc of the adult fly. The terminal joint of the galea bears two sensory papillæ connected with ganglionic sensory nerve terminations. Dr. Weismann regarded them as the homologues of the antennæ and maxillary palpi respectively, an opinion which is clearly untenable if the organ is a galea, and one which is likewise at variance with Dr. Weismann's own observations on the development of the organs which I have identified with the galea of the maxilla.

In front of the mouth of the larva a strongly chitinised labrum is present with a pair of thin membranous margins. Behind, the orifice is bounded by the three-lobed labium already described.

I am at present engaged in working out the development of the proboscis of the adult fly, but I will indicate the conclusions to which I think our present knowledge points, and which I expect to be verified by further research.

M. Kunkel de Herculais,* in his unfinished monograph on the genus Volucella, states that the head of the flies is developed from three pairs of "histoblasts," as he names the imaginal discs of Weismann; and so far as my present investigations have gone, I think M. de Herculais is right.

One pair form the optic and antennal discs of Weismann; these are in relation with the cephalic or preæsophageal ganglion, and are doubtless the modified procephalic lobes; a second pair lie in the basal joint of the galea, and a third appear to belong to the labium.

The third pair, or labial discs, apparently coalesce around the salivary duct, a fact known to Cuvier, who regarded them as the representatives of the mandibles, and one which Dr. Weismann has verified.

* "Anatomie des Volucelles." Paris—in progress.

M. Menzbier* thinks the head is developed from six pairs of histoblasts, but as he confesses he cannot find them, this may be regarded as a mere opinion. It cannot be said that the further development of the histoblasts of the galea has been traced, but these are the largest in the head if we omit the procephalic discs. Any others which may exist must be of small size. The conclusion at which I have arrived is that these form the greater part of the proboscis.

If the above view proves correct, the homologies of the proboscis and its relations to the larval and embryo states of development becomes simple. The whole exterior of the proboscis, except the labrum, would represent the galeæ and stipes of the maxillæ, whilst the edges of the labrum and its apodemes represent the lacinia or mando. Under this view the position of the maxillary palpi is no longer abnormal.

With regard to the labium the coalescence of the labial histoblasts with the salivary duct indicates that it forms the floor of the groove between the lips and the basal joint of the proboscis, that is, the labium is retracted within the galeæ of the maxillæ, and these have coalesced behind.

The intimate relation of the salivary duct with the labium of the larva, and the existence of a suctorial or quasi-suctorial disc around the mouth of the larva with rudimentary pseudotracheal grooves, are very suggestive. The existence of a large histoblast or imaginal disc in this region is not to be overlooked, and I would add the pharynx of the larva is almost identical with that of the imago. All these points are distinctly in favour of the view I have endeavoured to place before you.

It may appear to some that so remarkable a modification of the maxillæ† is improbable, but on this point I will merely observe now that the maxillæ exhibit a wide deviation from their primitive form in the Lepidoptera, and that the maxilla being serially homologous with the labium, there is no *à priori* ground for denying similar deviations from their primitive form in the two cases. If the paraglossæ of the labium are capable of so wide a modification, why not the galea of the maxilla? Hereafter I shall show that the structure of the mouth-parts of other diptera is consistent with the view I have laid before you.

* *Loc cit.*

† Brullé—"Researches sur les transformations des appendices dans les articules" ("Ann. Sc. Nat." 3rd ser., tom. ii.)—speaks of the proboscis as consisting largely of the galea; either we must admit that the maxillæ are united with each other or with all the other parts of the mouth.

On Diatom Structure.

By T. F. Smith.

(Read June 24th, 1887.)

It is not my intention to-night to read an exhaustive paper on diatom structure; to do so would be to attempt to thresh out an already well-threshed-out subject, and an insult to the intelligence of the members of this Club; several of whom certainly, and the whole probably, know more about the subject than myself. There are, however, still a few outstanding matters in connection with the structure of the more complex diatoms; such as the position, and the absence or presence of certain membranes that still remain in abeyance; and, possessing several slides, as I do, that seem to me to carry the question a step or two further, I thought it might be of interest to exhibit them here to-night, and give you my own ideas of the structure shown.

It would be useless, however, to try to get at the finer structure of diatoms with dry or even water-immersion lenses; for however good in themselves, the limit of angle is reached, and you can get no further; but Messrs. Swift and Son have kindly furnished me with four stands and glasses, in addition to my own, and I am consequently enabled to show you five of my objects at once, under $\frac{1}{12}''$ oil-immersion lenses. Should you, however, find any deficiency in the manner in which they are shown, I must ask for your forbearance, as I am new to the work, and this is the first time I have attempted to exhibit anything in public, and unfortunately, at a time like this, the demonstrator is more likely to exhibit himself than the objects.

On May 28th of last year you were fortunate enough to have two papers on diatom structure read before you in one night; one by Mr. Morland, and the other by Mr. Deby; and, with the exception of the discrepancy between them of a closed membrane, or the want of one, those papers may be said to embody the ideas of general structure brought up to date.

Here I should like to stop, but two other papers, with their plates, have been brought before you by Messrs. Nelson and Karop, which to me, in some parts, seem to confuse and unsettle our ideas of structure already fixed, in a certain way, by the consensus of microscopic opinion.

These drawings of the finer structure of certain diatoms, admirable as they are as illustrations, give, I am afraid, in three instances at least, misreadings of the structure, and I hope these gentlemen will not think me presumptuous if I venture to point out where I think they are wrong.

In Fig. 1 of their plate, given in the May number of the Journal of this Club for last year, is a drawing of the finer structure of *Coscinodiscus asteromphalos*, and were the figure only given, there would be nothing more to say, showing as it does correctly, the finer structure of that diatom, but the letterpress goes on to say: "This diatom, although consisting of a single siliceous membrane, has a double structure, viz., coarse and fine areolations, the latter within the former." By this I understand they mean that both structures are on, or nearly on, the same plane; but, as a matter of fact, each single disc of this diatom has three thicknesses of structure, each differing from the other. You have first the outer membrane, as figured; next, underneath this, a layer of hexagonal cells; and then an inner plate of so-called eye-spots; and I can only account for the outer membrane only being seen by assuming that the $\frac{1}{12}''$ oil-immersion used by these gentlemen had not working distance enough to allow them to focus through the whole thickness of the disc. On stand No. 1 you will find a disc of *Coscinodiscus asteromphalos* with bits chipped out of the middle, and you will be able to see for yourselves the different layers of structure. In the part shown the under membrane with the hexagons, is intact, but in another part the whole of the layers are torn through. You will also observe that the structureless part is the part torn away, proving that the space between the areolations is the thinnest part of the membrane.

In Fig. 1 of Plate IV. in the last number of the Journal, is a drawing purporting to give the finer structure of *Coscinodiscus centralis*, and here certainly are hexagons, but on the wrong side of the outer membrane. My mind was greatly exercised over this figure, as I had lately been looking at a great number

of specimens of *Coscinodiscus*, and could not make it fit in anyhow. Hitherto I had found all the structure alike, but here was something that upset all my generalizations. Nature is variable, but she is not capricious, and it did not seem possible that two diatoms that, seen through a medium power looked so exactly alike, could be constructed on such different principles.

Not only, however, are the two layers of structure reversed, but the finer structure of this diatom is missed altogether, and what Messrs. Nelson and Karop have figured as the fine perforations, to me are little bosses standing out from the outer membrane in the position shown, but whether standing on the hexagons and piercing through, or simply standing on the membrane itself, I am unable to determine. These bosses I take to be simply decorative, and agree with other species of *Coscinodiscus*, and also with *Triceratium favus*. The dot shown in the centre I cannot account for, except as a ghost of the eye-spot just vanishing as the object-glass was focussed down from the wrong side.

Plus the bosses, I see no difference between *Coscinodiscus centralis* and *asteromphalos*, except that the former is smaller, and has the finer perforations so small as to tax the utmost power of the microscope. On stand No. 2 you will find this diatom, and the disc is in the same position, I imagine, as the one through which Messrs. Nelson and Karop focussed—that is, with the eye-spots upwards. Now, if you work carefully through the disc you will find, first the eye-spots, next the hexagons, then the outer membrane, with the large areolations, the floor of which is filled up with an outer ring of larger perforations, and the centre with twenty or thirty smaller ones; and, finally, lowest of all, four or five little green bosses that occupy the position that the corners of the hexagons did when in focus.

Another disc, with the outer side up, shows the finer perforations distinctly. Another, with little bits chipped out of the centre, will enable you to study it in section; and the same disc will also show you the little bosses plainly, but this time nearest the eye. I now come to Fig. 11 on Plate IV, which purports to give the finer structure of *Aulacodiscus Kittonii*, and here, I am afraid, it is not a question of reversing the structure, but misreading it altogether. I may say that I have

been using these plates as a test for my own $\frac{1}{12}''$ oil immersion, and, allowing for the difference of N.A. between 1·25 and 1·43, was at first satisfied to find that my glass gave on this diatom the same indications of structure. On a second sitting, however, I discovered a layer of eye-spots with thickened edges on the under side; and my experience tells me that a structure of hexagonal cells is always built upon the top of these, and that in spite of appearances this is the structure in this case. The blacker dots shown in the figure in the shape of hexagons I take to be spurious, but the lighter ones in the centre not, being the perforations in the usual covering membrane.

I grant appearances are, at first sight, against me, and it may seem rash of me to pit myself and my humble glass against the best manipulators in England, working with the most advanced optical appliances; but with all deference, I must still stick to my opinion that straight-sided cells and not black dots is the true structure.

This is no new question, as in the April number of the "Monthly Microscopical Journal," for 1871, is a photograph of a *Coscinodiscus*, by Dr. Woodward, of America, and in the letter-press he says: "On one side the hemispheres are quite a little distance apart. On the other side they are crowded together, producing the *spurious* appearance of a hexagonal framework with little spherical beads at the corner." After this prompt suppression of the hexagons by our then greatest authority on diatom structure, I find no mention of them until December 4th, 1872, when Mr. Slack expressed a timid opinion that the hexagons were real, but in order to confine this new teaching within the limits of the orthodoxy of the day, decided that they were beaded. But what I particularly want to call your attention to, as bearing on the structure of *Aulacodiscus Kittonii*, is a discussion that also took place in what Mr. Crisp so aptly calls "the dark ages," that is, before the advent of oil immersion object glasses, on the structure of *Coscinodiscus oculus iridis*, in which Mr. Slack expressed an opinion that each side of the hexagons was made up of two rows of little beads. Mr. Slack, no doubt, saw beads, as at that time he and nearly all microscopists saw beads in nearly all diatom structure; but the reason for seeing them was that the true structure was just outside the grasp of the object glasses of that day, and when

you cannot see clearly, you see what you want to see, whether beads or perforations.

Now, the structure of *Aulacodiscus Kittonii* is very fine, and stands to-day in relation to the defining power of the widest angled oil immersions as *Coscinodiscus oculus iridis* stood in relation to the objectives of 1873, just outside the limits of their power. And as we cannot in this case trust to appearances, analogy should be our guide, and we must argue from the known to the unknown. Nobody now looking at a *Coscinodiscus* with an oil immersion would conclude that the hexagons were beaded, and I think we may reasonably reject the black dots when we see them in the finer diatoms. Of course, I do not reject the paler markings, as they are in accordance with well-known structure, and belong to the membrane on the top of the hexagons. The inner layer of eye-spots is the only thing clearly seen; and, given your layer of eye-spots, to construct your diatom you place your hexagons on this layer, and then stretch a fine perforated membrane on the top, and that is all. But there is other evidence on which I rely, and for this proof I refer you to the January number of our Journal for this year, where, in Plate II, Figs. 8 and 9, you will find an *Aulacodiscus*, which the authors of the paper have named *cellulosus*. Fig. 8 is the whole disc magnified 400 diameters, and Fig. 9 a part magnified 1,000. Both figures show clearly the straight-sided cells, and Fig. 9 shows fine dots inside the hexagons; and although I have not examined the diatom, I have no doubt but what it will show all the details belonging to the hexagonal structure, from the eye-spots in the inner layer to the fine perforated membrane in the outer. Another thing which confirms me in this opinion is the centre rosette, which this diatom has in common with *Aulacodiscus Kittonii;* and as far as my experience goes, this always means the same sort of structure.

I have not this last diatom under a microscope at present, but I have a very interesting slide through which I shall be most happy to pilot you directly. When I bought it, it formed a symmetrical group, but owing to the slipping of the cover it is now in fragments, out of which I hope to be able to find enough to confirm my views. You will see that some of the hexagons are torn clean away, and some of the bits have turned over, and

exhibit the eye-spots nearest the eye, and you may observe how exactly alike the appearance is to that of *Coscinodiscus*.

There now remains, first, the question of the position of the perforated membrane, which is found on one side of most diatoms having the hexagonal structure; and, second, whether the eye-spot, which is always found on the other side, is closed with a membrane or remains a large perforation. With regard to the former, my own opinion is that the fine perforated membrane is generally stretched outside the hexagons; and sometimes at a considerable distance from it. I have five slides here to-night that seem to me to confirm this view, two of which I have described, and it remains to describe the other three.

On stand No. 3 is a *Coscinodiscus* from Richmond, Virginia, having a spine standing out at each corner of the hexagons, and considerably above them, but just within the point of the spines is stretched a very fine membrane. The specimen is torn, and you will see the free edge of the membrane projecting beyond the hexagons.

On stand No. 4 is a *Triceratium*, in which the fine membrane is chipped off from over parts of three or four hexagons, and if you study the torn edge of the membrane I think you will see that it is altogether outside.

On stand No. 5 is a *Triceratium* with the raised margin of one side chipped away, and here also, I think, a study of the torn edge will lead you to the same conclusion. At one spot the hexagons project beyond the torn edge of the membrane.

On whether the eye-spot has a closing membrane in all cases I offer no definite opinion; but I have two slides which seem to prove that in some instances there is one.

In the same slide, from the Oamaru deposit, is a half disc of a *Coscinodiscus*, and there is no doubt about the closing membrane there; but what is curious about it is, that the centre of each is granulated as if the process of wearing away was begun. In other parts the centre is wanting, but the eye-spot has no thickened edge. One other slide I have with a specimen of a smashed *Coscinodiscus* from Jutland. The eye-spots are nearest the eye, and in one of the spots is a fine membrane torn across, showing the edge most distinctly. This is too delicate an object to see well with an Abbe condenser.

On a Fossil Marine Diatomaceous Deposit from Oamaru, Otago, New Zealand.

By E. Grove and G. Sturt, F.F.R.M.S.

Appendix.

Plates X, XI, XII, XIII, XIV.

Since the publication of Parts I, II, and III, of this paper a considerable number of additional species have been discovered, a list of which we now give.

Amphora tessellata, n. sp., Gr. and St.—Rectangular, ends rounded. Inner margin straight. Median line incurved with distinct nodule. Surface covered with large granules, about 11 in ·001″, arranged rectangularly like those of *Plagiogramma tesselatum*. Length of specimen figured ·004″. Rare. (Pl. X, Fig. 1.)

A. interlineata, n. sp., Gr. and St.—Oval. Median line gently incurved, nodules distinct. Striæ parallel (about 22 in ·001″), divided longitudinally by a distinct clear space. Length ·0055″. The apices of the valve project inwards prominently. Not frequent. (Pl. X, Fig. 2.)

A. subpunctata, n. sp., Gr. and St.—Oval. Outer margin convex, with stauros. Median line incurved. Striæ dotted, about 15 in ·001″. Space between median line and inner margin strewn with scattered puncta. Length ·005″. Rare. (Pl. X, Fig. 3.)

A. contracta, Grun., var.?—Closely resembles A. Schmidt's figure ("Atl.," Pl. 25, Fig. 62), but has coarser striæ (about 14 in ·001″). Length ·006″. Rare. (Pl. X, Fig. 4.)

A. obtusa, Greg. ("T. M. S.," Vol. iv, p. 72; Vol. v, Pl. 1, Fig. 34).—A large form resembling Gregory's species, but with coarser striæ, about 37 in ·001″. Length ·006″. Rare.

Cocconeis nodulifer, n. sp., Gr. and St.—Valve small; in outline and general characteristics resembling *C. distans*, Greg. ("Diat. of the Clyde," p. 18, Pl. 1, Fig. 23), but distinguished

by the presence of two nodules, situated on the longitudinal axis of the valve, midway between the centre and extremities. Longest diameter about ·0015″. Rare. (Pl. X, Fig. 5.)

Navicula inelegans, n. sp., Gr. and St.—Valve in frustular view very convex, in outline spindle shaped, usually with an enlarged centre, but very variable in this respect. Striæ sub-radial, about 37 in ·001″, reaching the central line. Owing to the convexity of the ends, the terminal nodules are not seen in the valvular view as is the case in *Stauroneis acuta*, W. Sm. (This form may be filamentous, and if so should belong to *Diadesmis*.) Length of specimen figured about ·0057″. Not rare. (Pl. X, Fig. 6.)

N. margino-punctata, n. sp., Gr. and St.—Valve resembles in outline *N. jamaicensis*, Grev. ("T. M. S.," Vol. xiv, p. 126, Pl. 12, Fig. 23), but differs entirely in other respects. On each side of the central line the valve is quite devoid of markings, but at the extreme margin are two rows of granules. Rare. Length ·0048″. (Pl. X, Fig. 7.)

N. trilineata, n. sp., Gr. and St.—Oval, median line and nodules distinct. Striæ costate, parallel, divided by clear longitudinal spaces into three distinct groups on each side. Length ·004″; breadth ·0013″. Rare. (Pl. X, Fig. 8).

N. biconstricta, n. sp., Gr. and St.—Valve trinodular, the end lobes being slightly broader than the central inflation. Median line and nodules conspicuous. Margin cellulate with short costæ about 20 in ·001″, not reaching to the centre line. Length ·0035″; breadth of end lobes ·00065″. (Pl. X, Fig. 9.)

N. dispersa, n. sp., Gr. and St.—Valve lanceolate, with subacute ends. Median line distinct. Striæ obscure (about 55 in ·001″), reaching to the centre line, excepting at the centre of the valve, where there is a clear oval space. As the striæ approach the margin they break up into scattered dots, leaving a submarginal clear space, which is broader towards the ends than at the centre of the valve. On the margin is a closely set row of small puncta. Length ·0047″. (Pl. X, Fig. 10.)

N. margino-lineata, n. sp., Gr. and St.—Valve small, slightly constricted, with an outline resembling that of *N. didyma*, Ehr. Median line and end nodules distinct. Central nodule slightly dilated. Margin edged with a closely set line of puncta, within which, separated by a narrow clear line, is a row of very short

striæ (about 21 in ·001″), the remainder of the surface being quite clear. Length ·0035″; breadth of end lobes ·001″. (Pl. X, Fig. 11.)

N. lobata, n. sp., Gr. and St.—Valve constricted at centre. Lobes oblong, with subacute ends. Median line distinct, with small central and end nodules. Striæ costate, conspicuous, not reaching the median line, and absent for a considerable space in the centre of the valve. Length ·00475″; breadth of lobes ·0012″. (Pl. X, Fig. 12.)

N. placita, n. sp., Gr. and St.—Valve flat, oval, with broad marginal belts of radial dotted striæ, about 30 in ·001″, leaving between them a lozenge-shaped clear central space. Median line very distinct with two central terminations rather wide apart. Length ·0023″. Breadth ·0013″. This form has some resemblance to *N. patula*, W. S. (" S. B. D.," Pl. 16, Fig. 139), but is broader, and has coarser striæ. (Pl. X, Fig. 14.)

N. decora, n. sp., Gr. and St.—A very elegant form. Valve oval, with rounded ends. Median line distinct, terminal nodules dilated sideways. Striæ distinctly dotted, parallel, about 18 in 001″, leaving a narrow, clear space on each side of the median line, which is slightly expanded at the centre. Towards the margin the striæ are interrupted by, first a narrow, and then a broader clear space, the striæ reappearing on the margin in the form of a row of very short costæ. Length ·0047″; breadth ·0019″. (Pl. X, Fig. 13.)

Donkinia antiqua, n. sp., Gr. and St.—Frustule greatly constricted. Valve ovo-lanceolate with subacute ends, occupying a middle position in outline betwee *D. compacta* and *D. carinifera* ("Pritchard," p. 921). Median line strongly sigmoid coincident with the margin at the ends. Central clear space small, circular. Striæ rectilinear, about 40 in ·001″. Length of valve ·0077″. We regret that, owing to the only specimen of this form discovered by Mr. R. Rattray having been injured after this description was written, we are unable to figure this interesting Diatom.

Biddulphia? fossa, n. sp., Gr. and St.—Valve flat, oval with obtuse ends, in outline resembling *Anaulus Mediterraneus*, Grun. (Pant., "Hungarian D.," Pl. 18, Fig. 160). Processes inconspicuous, scarcely more than slight elevations of the ends of the valve, covered with finely dotted lines. Surface of valve dotted with

papillæ, which are absent from a small circular space in the centre. Two depressions in the form of clear furrows separate the central portion from the ends. Length ·0034″; breadth ·002″. (Pl. X, Fig. 15.)

B. dissipata, n. sp., Gr. and St.—Valve oval, with subacute ends, convex, with a depressed clear circular space in the centre, in which is a spine mounted on a small hyaline projection. Processes conspicuous, inclined laterally in opposite directions, arising from slightly bullate inflations, commencing near the centre. Surface, excepting at the clear centre, dotted with small widely separated puncta. Length ·004″; breadth ·0026″. (Pl. X, Fig. 16.)

B. vittata, n. sp., Gr. and St.—Valve lanceolate, with central constriction and acute ends. On each side of the centre are two transverse vittæ, or septa, dividing the interior of the valve into five compartments. In frustular view the compartments are seen to be of nearly equal height, the processes projecting but slightly. The surface is covered with large circular granules, excepting at the extremities of the processes, which are finely punctate. On the summits of the compartments are a few scattered spines, which have disappeared in the specimen from which our frustular view was figured. Length to ·0045″. (Pl. XI, Figs. 19, 20.)

B. tenera, n. sp., Gr. and St.—Frustule very hyaline, with central depression bearing a stout spine, and an elevation or inflation on each side. Processes well developed, similar in form to those of *B. aurita*. Valve narrow, oval, with produced extremities. Surface of the inflations covered with minute dots. Length ·0025″. (Pl. XIV, Figs. 56, 57.)

B. (Cerataulus?) reversa, n. sp., Gr. and St.—Valve oval, with broadly rounded ends and two mastoid processes placed on opposite sides (as in *Cerataulus turgidus*, from which in other respects it is distinct). In the centre is a group of numerous small spines, on each side of which is a narrow transverse hyaline space, the remainder of the surface being covered with exceedingly fine dots. Frustular view not observed. Length ·0025″. (Pl. XIV, Fig. 62.)

B. punctata, Grev.—Since our notice of the occurrence of this species ("J. Q. M. C.," Vol. ii, Ser. ii, p. 325), some frustules have been found in which the conspicuous crenulation of the connecting membrane (traces of which are apparent in most of the valves met with in this deposit) is well shown. As this is

absent in Dr. Greville's drawing, we give a figure from an excellent specimen in the cabinet of Dr. Gray. (Pl. XIV, Fig. 51.)

B. lata, n. sp., Gr. and St.—Valve broadly oval, with four slightly tapering processes close to the margin. The surface, which is moderately convex, is covered with distinct puncta or small spines. Length of valve ·0055″; breadth ·0047″.

Our figure is given from a magnificent specimen of this fine diatom in the collection of Herr J. Kinker, of Amsterdam. (Pl. XIV, Fig. 53.)

Cerataulus marginatus, n. sp., Gr. and St.—Valve circular, with flat upper surface arising from a broad striated base. In the centre is a group of dots surrounded by an annular clear space, whence distinct lines of dots radiate to the margin, having between them numerous subulate blank spaces. The processes, two in number, are conspicuous, with obtuse ends, and between them, on each side, on the margin of the elevated portion of the valve, is a small spine seated on a small nipple-shaped projection. Diam. ·0033″. (Pl. XI, Fig. 21.)

Triceratium oamaruense, n. sp., Gr. and St.—Valve large, gibbous, sparsely dotted. The apices are covered with minute dots, and are cut off from the central portion by curved lines, which are very distinct at the margins and fade away towards the middle. Length of side to ·0085″. (Pl. X, Fig. 18.)

Note.—This form was described by us in the first part of this paper ("J. Q. M. C.," Vol. ii, Ser. ii, p. 327) as *T. partitum*. Grev., but we have since ascertained from an inspection of Greville's original examples that it is a quite distinct species.

T. rectangulare, n. sp., Gr. and St.—Valve quadrangular, with gibbous sides. A distinguishing feature of this form is the large flat central rectangular elevation, terminating at each angle in a prominent process or horn. The surface is covered with radial lines of large granules, except in a small clear central place. Breadth ·004″. (Pl. X, Fig. 17.)

Note.—Since the above figure was drawn, other specimens have been observed, in which the processes are club-shaped and conspicuously spinous. From this it appears that in this species, as in *T. rugosum*, Gr. and St. (see below), the valves in each frustule are dissimilar in the form of the processes.

T. rugosum, n. sp., Gr. and St.

Note.—Since describing and figuring this species (*supra*, p.

75, Pl. 5, Fig. 4), we have, through the kindness of F. Kitton, Esq., inspected a perfect frustule, from which we learn that the valves differ greatly in the length and form of the processes, those in the one valve being long and taper, while those in the other are club-shaped and spinous.

We give a figure of the frustule. (Pl. XI, Fig. 26.)

T. cordiferum, n. sp., Gr. and St.—Valve with slightly convex sides and rounded angles. Processes distinct, circular, hyaline. Surface of valve closely punctate, excepting where a conspicuous clear space, having the outline of a heart, divides the central portion from the rest. Length of side ·0025″. (Pl. XI, Fig. 23.)

T. weissflogii, n. sp., Gr. and St.—This species was previously described by us ("J. Q. M. C.," Ser. ii, Vol. ii, p. 328) with hesitation as *T. cœlatum*, Jan., from its resemblance to the figure of that species in A. Schmidt's "Atlas" (Pl. 81, Fig. 19). Recently, through the kindness of Herr C. Janisch, we have examined an authentic example of his species, and have come to the conclusion, in which Herr Janisch agrees, that the two forms are specifically distinct. We have, therefore, much pleasure in naming the Oamaru form after the well-known diatomist, Herr Weissflog, of Dresden, whose assistance has been of great value to us in this work. Valve nearly flat, with straight sides and slightly rounded angles. The apices, which are large, and project but slightly, are covered with delicate points. The centre is sparsely punctate, but the radiating lines increase in number till at the margin they form crowded lines. Length of side to ·0075″.

We figure a specimen of average size. (Pl. XI, Fig. 22.)

T. pseudo-nervatum, n. sp., Gr. and St.—This species was described and figured previously ("J. Q. M. C.," Ser. ii, Vol. ii, p. 329, Pl. 19, Fig. 19) as *T. cancellatum*, Grev., but since then, having inspected Greville's authentic specimens, we have ascertained that it is a distinct species. Valve with straight sides, with a flat central triradiating portion, from which rises an inclined plane to each apex.

The intersection of these planes with the flat central portion presents at the margin of the valve the appearance of a short nerve or vein, two of which are conspicuous on each side. Our figure is a little misleading, as the "nerves" are made to resemble papillæ. In the centre of the valve there is usually a spine, not shown on the figure. The processes are prominent,

with rounded ends. Length of side to ·003″. This form is very common on the deposit.

T. eccentricum, n. sp., Gr. and St.—Valve with nearly straight sides and very rounded angles. Processes prominent, situated on one side of the angles formed by the sides. Surface of valve reticulate. Length of side ·003″. (Pl. XIV, Fig. 61.)

T. arcticum, Brightwell.

Note.—Herr Janisch informs us that the large form of this species previously mentioned ("J. Q. M. C.," Ser. ii, Vol. ii, p. 326) is the same as *T. permagnum*, Jan., to be described and figured in his forthcoming work on the Diatomaceæ of the *Gazelle* Expedition. Through his kindness we have been enabled to examine an authentic specimen of *T. permagnum* from Kerguelens Land, and we have no doubt of the identity of the two forms. A large quadrangular form of the same with very produced angles also occurs in this deposit.

The cellulation of these large *Triceratia* is rather smaller, and the punctation of the pseudo-nodules more delicate, than in the usual form of *T. arcticum*; but in all respects they exhibit the features of the group, and we consider them as large forms of the species.

T. arcticum, Brightw., *forma quinquelobata* (*T. quinquelobatum*, Grev., " T. M. S.," Vol. xiv, p. 83, Pl. 9, Fig. 21).—Scarce.

T. montereyi, Brightwell.—Having met with specimens of complete frustules of this form since we recorded its occurrence, we figure one showing the extreme convexity of the terminal valves (Pl. XI, Fig. 25.)

T. favus, Ehr., *forma pentagona.*—One or two examples of this have occurred.

T. grande, Brightw., *forma quadrata.*—Many of the quadrate forms of the *favus* group, which are abundant in this deposit, are convex, and in all respects, except outline, are so similar to *T. grande* that we place them here.

T. stokesianum, Grev. (" T. M. S.," Vol. xiv, p. 8, Pl. 2, Fig. 23).—We have met with several specimens of a large *Triceratium*, which resembles the form in the Brünn deposit identified by Prof. Cleve ("J. Q. M. C.," Vol. ii, Ser. ii, p. 169, Pl. 12, Fig. 5) with Greville's species.

T. exornatum, Grev. (" T. M. S.," Vol. xiii, p. 9, Pl. 2, Fig. 25). —Scarce.

T. repletum, Grev. ("T. M. S.," Vol. xiv, p. 83, Pl. 9, Fig. 18). —Very rare.

T. plumosum, Grev. ("T. M. S.," Vol. xii, p. 85, Pl. 10, Fig. 4). —A form has been observed resembling this in all respects except that pseudo-nodules are present. We prefer to class it as Greville's form rather than to introduce confusion by making a new species of it.

T. condecorum, Ehr. (Schm. "Atl.," Pl. 76, Fig. 28).—Scarce.

T. trisulcum, Bailey ("Prit.," p. 854, Pl. 8, Fig. 27).—Not scarce.

T. barbadense ("T. M. S.," Vol. ix, p. 44, Pl. 4, Fig. 12).—This species occurs rarely, but appears to agree with Greville's authentic examples. The figure above cited is not good, and we append one. (Pl. XI, Fig. 24.)

T concinnum, Grev. ("T. M. S.," Vol. xii, p. 13, Pl. 2, Fig. 7). —Very scarce.

T. (Stictodiscus) parallelum (Ehr.), Grev.—A form of this with seven angles has been found by Dr. Gray, and the same indefatigable observer has discovered an oval form of the var. *gibbosa*, with acute ends, resembling in outline a *Biddulphia*, of which we give a figure. (Pl. XIV, Fig. 28.)

T. shadboltianum, Grev. (Sch. "Atl.," Pl. 80, Figs. 18-20).—Small forms, with three flat processes, apparently of this species, occur here.

Lampriscus ? debii, n. sp., Gr. and St.—We place this singular form in this genus with great hesitation for the present.

Hitherto only two specimens have been observed, and we are indebted to Julien Deby, Esq., for first calling our attention to it. It is to be hoped that further examples will be discovered, from which the true character of this diatom can be ascertained. Valve circular, with two large marginal processes (?) opposite each other, between which occur smaller marginal processes (?) unequal in number (on the one side three, on the other four). The centre is flat, with a clear umbilicus, on which is a group of spines, the rest of the surface being covered with curved lines of dots, which converge towards the bases of the processes (?) somewhat as in Auliscus. Diam. ·0055″. (Pl. XI, Fig. 27.)

N.B.—The figure shows the valve as viewed from the inside, as the specimen was mounted with that side uppermost.

Aulacodiscus janischii, n. sp., Gr. and St.—This species has been hitherto considered by us as *A. stoschii*, Jan. The first forms observed were smaller than those which have occurred in samples of the material obtained since, and closely resembled the figure of *A. stoschii* in Messrs. Walker and Chase's work referred to by us (*supra*, p. 8). Herr Janisch has, however, kindly allowed us to examine an original example of his form, and we find that the Oamaru species differs entirely. We have much pleasure in naming this fine Diatom after one who has done so much in furtherance of the knowledge of the Diatomaceæ.

Valve large, with moderately convex centre, from which extend seven bullate expansions, ceasing close to the margin; from the ends of which project the small cylindrical processes.

Between each expansion there is usually an undulation which is very conspicuous in the larger examples. The furrows are very distinct at the processes, but as they approach the centre are gradually lost on the rough granular surface of the valve, which is covered with crowded radiating lines of dots.

Diam. to ·02″. (Pl. XI, Fig. 28.) (A small example).

A. janischii, var. *abrupta*.—This form has usually *six* processes. The convex centre does not branch into the bullate expansions as in the type form, but they rise from its edge and terminate abruptly on the margin. They are broader at the ends, and more conspicuous than in the type. Diam. to ·005″.

NOTE.—This form approaches very nearly to *A. mammosus*, Grev. ("T. M. S.," Vol. xi, p. 70), of which it may be a six-processed form.

A. rattrayii, n. sp., Gr. and St.—We at first considered this species as one of the forms of *A. beeveriæ*, Johns., but further examination and comparison with an authentic specimen of that rare form in the possession of our friend, F. Kitton, Esq., have convinced us that it is distinct. We have much pleasure in naming it after the well-known diatomist, Mr. R. Rattray, of Dundee, who has assisted us so materially in the examination of this deposit.

Valve convex, with flattened margin and striated rim. Processes usually three, small, oval, considerably within the margin. Cellules hexagonal, about 10 in ·001″, strongly papillate, closely covering the surface in radiating lines, with the exception of a small irregular clear umbilicus. Scattered spines occur giving the surface a scabrous appearance, especially near the margin. Furrows formed

by two conspicuous parallel rows of cellules. Forms with two processes are not infrequent. Diam. ·006″. (Pl. XI, Fig. 29.)

The main distinction between *A. beeveriæ* and *A. rattrayii* is that the latter has an hexagonal cellulation, whilst the former is characterized by distant radiating lines of large pearly granules.

A. comberi (Arnott), var. *oamaruensis*, Gr. and St.—Valve moderately convex, and not so lurid in colour as the type form. Processes, in the few specimens observed, three; small, oval, submarginal. Margin striated. Cellules about 9 in ·001″, with a small clear umbilicus, and a small clear space at the base of each process. Furrows distinct. Diam. about ·007″. Scarce.

A. elegans, n. sp., Gr. and St.—Valve with convex edges and rather flat upper surface. Cellules hexagonal, papillate, about 10 in ·001″, merging into dots at the centre, where there is usually a small circular clear space. Processes in the specimens observed, 5, 6, or 7, narrow, prominent, cylindrical. No clear space at the base of the processes. Furrows represented by the walls of two adjacent parallel lines of cellules. Scarce. Diam. about ·007″. (Pl. XII, Fig. 30.)

A. huttonii, n. sp., Gr. and St.—Valve with convex centre and an undulation between centre and margin. Processes, usually four, papilliform, submarginal, projecting vertically. Cellules granular, large, confused in the middle, but passing into distinct radial lines, which are very conspicuous towards the margin. Surface between the granules delicately punctate. It has an irregular clear umbilicus and distinct furrows, which widen as they approach the processes. Not scarce. Diam. ·004″. (Pl. XII, Fig. 31.)

A. convexus n. sp., Gr. and St.—Valve oval, very convex, with hexagonal cellules, about 10 in ·001″, papillate with an umbilical group of larger cellules.

Processes three, submarginal, enlarged at the end in a spathulate form, springing from a small clear space. Longest diam. about ·006″. Scarce. (Pl. XII, Fig. 32.)

A. cellulosus, Gr. and St., var. *plana*.—Differs from the type form in being less convex, and having (in all specimens yet observed) four processes only. Not very scarce. Valve usually about ·008″, in diam.

A. radiosus, n. sp., Gr. and St.—Valve large, moderately convex, with a small circular umbilicus of cells, the rest of the surface being covered with minute hexagonal cellulation, about 9 in ·001″,

arranged in close radiating lines. Processes (in the only specimen observed) seven in number, small, but conspicuous, and slightly inflated, arising from a small hyaline space. Diam. ·01″. (Pl. XII, Fig. 33.)

We are indebted to Mr. Rattray for the discovery of this species.

A. spectabilis, Grev. ("T. M. S.," Vol. xi, p. 71, Pl. 5, Fig. 16). An example of this form has occurred, differing only from Greville's in having four processes instead of five.

Auliscus propinquus, n. sp., Gr. and St.—Valve circular, with a clear umbilicus, and two large mastoid processes close to the margin of the umbilicus. Markings granulose in curved lines, with brilliant puncta interspersed, diminishing in number as they approach the margin. Within the margin is a ring of larger puncta. Diam. ·0022″. (Pl. XII, Fig. 34.)

We are indebted to W. J. Gray, Esq., M.D., for the discovery of this beautiful *Auliscus.*

A. lacunosus, n. sp., Gr. and St.—Valve large, slightly oval, with large mastoid processes close to the margin, at the base of which on the inner side is a crescent-shaped clear space or lacuna. Markings very similar to those of *A. punctatus*, Bail. Diam. ·0023″. This form is not infrequent in the deposit. We figure a somewhat abnormal specimen. (Pl. XII, Fig. 35.)

A. lineatus, n. sp., Gr. and St.—Nearly circular, with a clear lozenge-shaped umbilicus, mastoid processes large, circular, or in some instances somewhat pear-shaped, seated on triangular raised spaces, the apices of which project inwards. Markings scabrous, resembling those of *A. hardmanii*, but differing entirely in the presence of three diverging ridges or elevations, showing lines on each side of the centre. Diam. to ·005″. The form figured has circular processes. (Pl. XII, Fig. 36.)

A. inflatus, n. sp., Gr. and St.—Valve circular, with clear circular umbilicus. Processes large, mastoid, seated at the extremities of a prominent inflation extending along the diameter of the valve. Markings consisting of fine lines with interspersed puncta; a set of curved lines converge from the centre towards each process. Diam. ·0034″. (Pl. XIII, Fig. 37.)

We are indebted to L. Hardman, Esq., for the discovery of this very fine form.

Monopsia, n. gen., Gr. and St.—Valve with discoid outline inflated, the inflation ending in a single mastoid process consider-

ably eccentric. Differs from *Auliscus* chiefly in having one process only.

M. mammosa, n. sp., Gr. and St.—Valve circular, with broad, flat, finely striated border (striæ about 55 in 001″), from which arises a highly convex expansion, terminating in a large circular process, on which are two rings of large dots. The process is not central, but is situated much nearer one side of the valve than the other, and somewhat resembles the mouth of a sack or bag tied up and leaning to one side. The surface of the expansion is covered with markings resembling those of *Auliscus pruinosus*, converging to the base of the process. Diam. ·003″. Rare. (Pl. XIII, Fig. 38.)

Huttonia, n. gen., Gr. and St.—We place under this name two species which appear to differ from those of any existing Genus, but further observation is necessary before we can define the Genus in which we propose to place them, and which we have named after Prof. Hutton, of Christchurch, New Zealand.

H. alternans, n. sp., Gr. and St.—Valve oblong with rounded ends, moderately convex, having at the ends, on the alternate sides, flattened appendages, which have somewhat the appearance of processes viewed laterally. Surface of valve covered with fine puncta. Length to ·0063″. (Pl. XIII, Fig. 39.)

H. virgata, n. sp., Gr. and St.—Valve similar to the last in outline, but with much coarser puncta, which are interrupted by broad transverse clear spaces irregularly placed. Length of the only specimen observed ·0042″. (Pl. XIV, Fig. 55.)

Actinoptychus (*glabratus* var.?) *elegantulus*, n. sp., Gr. and St.—Valve small, with large clear centre, from which hyaline rays extend for some distance between each compartment. Margin hyaline, with large clear spaces between each process. Processes small, seated on a small, crescent-shaped, hyaline space, connected with the centre by a narrow ray. Surface of the undulations covered with delicate decussating lines of striæ. Rare. Diam. ·0025″. (Pl. XIII, Fig. 40.)

A. pulchellus, Grun., var. *tenera*.—Small, with numerous compartments, and a large clear centre. The undulations are conspicuous, and the small but distinct processes are situated in small clear spaces at the ends of the elevations, which terminate abruptly. On the summit of each elevation is a clear radial line, the remainder of the surface being covered with fine decussating striæ. (Pl. XIII, Fig. 41.)

A. undulatus, Ehr.—Small forms of this occur with extreme rarity.

A. (*undulatus*, Ehr. var.?) *constrictus*, n. sp., Gr. and St.—Valve with three undulations and three distinct processes. In the margin of the valve there is a constriction of the inner edge of the margin at the end of each of the rays, which gives to the form a very distinct appearance. The compartments are more sparsely cellulose than is the case in *A. undulatus*, Ehr. Diam. ·0033.″ (Pl. XIV, Fig. 63.)

A. simbirskianus, A. Sch.—An example of this has occurred.

Porodiscus hirsutus, n. sp., Gr. and St.—Valve, with clear circular central space, about $\frac{1}{5}$ of the total diameter, the remainder of the surface being covered with papilla which are very much coarser than in *P. interruptus*, and are not interrupted near the margin as in that species. Diam. ·0027″. (Pl. XIV, Fig. 54.)

Asterolampra uraster, n. sp., Gr. and St.—Valve rather coarsely reticulated, the interior extremities of the cellular compartments angular with slightly rounded ends. Centre, of a few large cells, connected by a radial line with the apex of each compartment. It will be observed that in the specimen figured, which is the only one observed, there are two radial lines connecting one of the compartments with the central cells. This is probably abnormal.

The clear spaces between the compartments are broad and tapering, ending considerably within the margin, and showing at the termination of each an indentation (possibly a spine?). We are indebted for the only specimen of this species to Dr. Gray. (Pl. XIII, Fig. 42.)

Anaulus? subconstrictus, Gr. and St.—We place this singular form here for the present with some hesitation.

Valve narrow with slightly expanded ovate ends, which are separated from the central portion by distinct septa. Surface covered with dots, which in the centre are arranged radially. In frustular view, the valve is very slightly constricted and has rounded ends. On the ventral side, at each end of the valve, there is apparently a folding over of the membrane or cell wall partly closing the interior. Length ·0045″. (Pl. XIV, Figs. 59, 60.)

Hemiaulus dissimilis, n. sp., Gr. and St.—In this form the contiguous valves are dissimilar. We figure a frustule, one of several which have occurred to us, from which it will be seen that one valve resembles that of *Hemiaulus*, with the usual processes or

horns terminating in spines; while the other has inflated extremities, but without horns or spines. (Pl. XIII, Fig. 43).

H. amplectans, var. *major*.—Differs from the typical form (*supra*, p. 76, Pl. 6, Fig. 17) in the greater length of the valve, and in being covered with granules instead of being hyaline. (Pl. XIII, Fig. 44.)

H. augustus, Grev. ("T. M. S.," Vol. xiii, p. 30, Pl. 3, Fig. 12)—Several specimens have been observed, which agree with Greville's figure, excepting that there is only one spine, projecting inwards at the extremity of each horn.

H ? tenuicornis, Grev.—We figure an example which has occurred to us of opposite valves of this species in conjunction, showing that the connection between the frustules is effected by an interlacing of the horns, and not, as in the true *Hemiaulidæ*, by the junction of terminal spines or claws. (Pl. XIII, Fig. 45.)

Note.—This being so, it appears that Greville was right in his doubt as to whether this and other allied species described by him ("T. M. S.," Vol. xiii, p. 29) rightly belong to *Hemiaulus*. We take the opportunity of correcting an erratum on page 11, *supra*, where "*tenuicornis*" is printed "*tenuiformis*."

Trinacria simulacrum, n. sp., Gr. and St.—This singular form is frequent in the deposit, but further investigation is required before it can be ascertained whether it really belongs to the Genus in which we placed it provisionally. It has been suggested that it may be an inner or secondary valve of *T. Kinkerii*, A. Sch. ("Atl.," Pl. 112, Fig. 21), but we think, if this were so, we should have met with the true valves of that species; which has not been the case. (Pl. XIII, Fig. 46.)

T. ventricosa, Gr. and St. (*supra*, p. 63, Pl. 5, Figs. 1, 2, 3). —Having, through the kindness of Dr. Stolterfoth, obtained a complete frustule of this form, we give a figure showing a pair of primary and secondary valves *in situ*. (Pl. XIII, Fig. 47.)

Coscinodiscus centralis, Greg. ("G. D. C.," p. 29, Pl. 3, Fig. 49). —In a sample of the deposit obtained recently, several examples of what appears to be this form have occurred. Diam. ·006″.

C. oblongus, Grev. ("T. M. S.," Vol. xiv, p. 4, Pl. 1, Fig. 9).—One specimen has been observed by F. Kitton, Esq., in this deposit,

Terpsinoe americana, Bail., *forma trigona* (Pantocsek, "Hung. Diat.," Pl. 6, Fig. 53).—A form very similar has been found by Mr. F. Marshall.

Melosira oamaruensis, n. sp., Gr. and St.—This species, which is abundant in the Oamaru deposit, belongs to the same group as *M. Sol.* Ehr., and *M. clavigera*, Grun. The form, when touched, readily breaks up into two discs, which differ from each other. We give figures of both. The primary disc has a smooth margin, and a clear centre, slightly raised. The margin is adorned with a ring of closely set spathulate costæ, in length about $\frac{1}{5}$th the diam.

The secondary disc has a crenulate margin, and a border of dotted striæ, within which the costæ are indicated by an annulus of detached lines. Diam. to ·006″. (Pl. XIII, Figs. 48, 49.)

Pyxilla? reticulata, n. sp., Gr. and St.—Single valves of this little Diatom are not uncommon, but we have hitherto not observed any complete frustules. Valve circular, slightly convex; in frustular view cylindrical, longer than the diameter. The whole surface is hexagonally cellulate. (Pl. XIII, Fig. 50.)

Stoschia? punctata, n. sp., Gr. and St.—We place here a form which, judging from the figure of *S. palacea*, Grun. (" V. H. Syn. Belg. Diat," Pl. 128, Fig. 6), appears to have affinities with the Genus. The surface is covered with small scattered granules. Length ·007″. (Pl. XIV, Fig. 52.)

Triceratium sexapartitum, n. sp., Gr. and St.—A single specimen of this, for which we have to thank Herr Janisch, reached us while correcting the proof of this paper. The valve has an hexagonal outline, with obtusely rounded processes. The centre is slightly depressed, and from this proceed very fine, thickly-crowded, radiating lines of granules. Still finer granules cover the processes, on each side of which are indications of internal veins. Frustular view not yet observed. Diam ·00345″. (Pl. XIV, Fig. 64.)

Corrigenda.

Opportunities of inspecting authentic examples of rare species which have, since the publication of the earlier parts of this paper, been afforded to us by the kindness of William Carruthers, Esq., F.R.S., F. Kitton, Esq., Herr Janisch, and other friends, have convinced us of the necessity of making a few changes in the names recorded. These changes have, for the most part, been indicated in the text, but we now give a summary of them. Our readers will be so good, therefore, as to cancel—

Biddulphia elaborata, n. sp., putting in its place *Kittonia elaborata*, n. sp.

Biddulphia virgata, n. sp., putting in its place *Kittonia virgata*, n. sp.

Aulacodiscus stoschii, Jan., putting in its place *Aulacodiscus janischii*, n. sp.

Aulacodiscus beeveriæ, Johnst., putting in its place *Aulacodiscus rattrayii*, n. sp.

Aulacodiscus comberi, Arnott type, putting in its place *Aulacodiscus comberi*, Arnott, var. *oamaruensis*.

Aulacodiscus decorus, Grev., putting in its place *Aulacodiscus elegans*, n. sp.

Aulacodiscus notatus, n. sp., putting in its place *Aulacodiscus barbadensis*, Ralfs., "Pritch.," p. 939.

Triceratium cœlatum, Jan., putting in its place *Triceratium weissflogii*, n. sp.

Triceratium cancellatum, Grev., putting in its place *Triceratium pseudo-nervatum*, n. sp.

Triceratium partitum, Grev., putting in its place *Triceratium oamaruense*, n. sp.

Auliscus barbadensis, Grev. var., putting in its place *Auliscus lineatus*, n. sp.

In our notice of *Triceratium grande*, Brightwell ("J. Q. M. C.," Ser. ii, Vol. ii, p. 326), we gave as a synonym *T. favus*, var. *maxima*, Grun., but not having seen authentic specimens of the latter, we do not feel assured of the identity of the two forms, and desire to note the large convex form so abundant in this deposit simply as *T. grande*.

We desire to record that since our first description of *Pseudo-rutilaria monile*, specimens have occurred in which the number of cells on either side of the centre is equal; also specimens in which the number on one side exceeds that on the other by more than one.

We also request our readers not to attach too much importance to the statements in the earlier parts of this paper as to the relative abundance of the various species. Subsequent examinations have shown us that the relative numbers of the species vary in every different piece of material, even from the same lump. One Diatom, however—*Stephanopyxis valida*, Grun.—asserts its pre-eminence in number in every sample we have examined.

PLATE X.

FIG. 1. *Amphora tessellata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 2. ,, *interlineata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 3. ,, *subpunctata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 4. ,, *contracta*, Grun. var., $\frac{400}{1}$.
,, 5. *Cocconeis nodulifer*, n. sp., Gr. and St., $\frac{800}{1}$.
,, 6. *Navicula inelegans*, n. sp., Gr. and St., $\frac{600}{1}$.
,, 7. ,, *margino-punctata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 8. ,, *trilineata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 9. ,, *biconstricta*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 10. ,, *dispersa*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 11. ,, *margino-lineata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 12. ,, *lobata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 13. ,, *decora*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 14. ,, *placita*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 15. *Biddulphia fossa*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 16. ,, *dissipata*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 17. *Triceratium rectangulare*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 18. ,, *oamaruense*, n. sp., Gr. and St., $\frac{250}{1}$.

PLATE XI.

,, 19. *Biddulphia vittata*, n. sp., Gr. and St., valvular view, $\frac{400}{1}$.
,, 20. ,, ,, ,, frustular view, $\frac{400}{1}$.
,, 21. *Cerataulus marginatus*, n. sp., Gr. and St., $\frac{350}{1}$.
,, 22. *Triceratium weissflogii*, n. sp., Gr. and St., $\frac{350}{1}$.
,, 23. ,, *cordiferum*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 24. ,, *barbadense*, Grev., $\frac{400}{1}$.
,, 25. ,, *montereyii*, Brightw., $\frac{400}{1}$.
,, 26. ,, *rugosum*, Gr. and St., frustular view, $\frac{300}{1}$.
,, 27. *Lampriscus* (?) *debii*, n. sp., Gr. and St., $\frac{300}{1}$.
,, 28. *Aulacodiscus janischii*, n. sp., Gr. and St., $\frac{250}{1}$.
,, 29. ,, *rattrayii*, n. sp., Gr. and St., $\frac{400}{1}$.

PLATE XII.

,, 30. *Aulacodiscus elegans*, n. sp., Gr. and St., $\frac{350}{1}$.
,, 31. ,, *huttonii*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 32. ,, *convexus*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 33. ,, *radiosus*, n. sp., Gr. and St., $\frac{250}{1}$.
,, 34. *Auliscus propinquus*, n. sp., Gr. and St., $\frac{400}{1}$.
,, 35. ,, *lacunosus*, n. sp., Gr. and St., $\frac{500}{1}$.
,, 36. ,, *lineatus*, n. sp., Gr. and St., $\frac{450}{1}$.

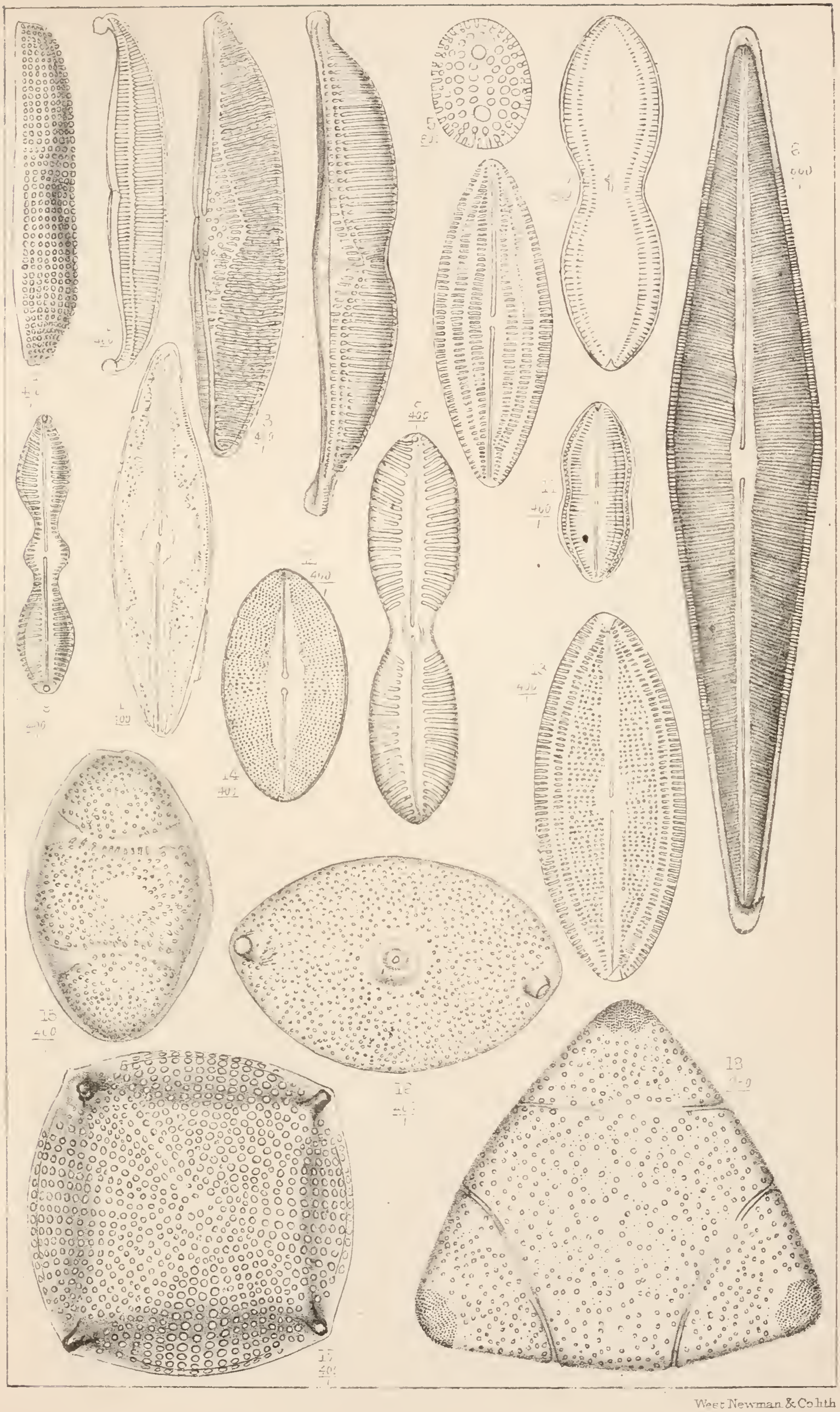
PLATE XIII.

,, 37. *Auliscus inflatus*, n. sp., Gr. and St., $\frac{500}{1}$.
,, 38. *Monopsia mammosa*, n. sp., Gr. and St., $\frac{450}{1}$.
,, 39. *Huttonia alternans*, n. sp., Gr. and St., $\frac{600}{1}$.

FIG. 40. *Actinoptychus* (*glabratus* var. ?) *elegantulus* n. sp., Gr. and St., $\frac{500}{1}$.
„ 41. *A. pulchellus*, var. *tenera*, Gr. and St., $\frac{500}{1}$.
„ 42. *Asterolampra uraster*, n. sp., Gr. and St., $\frac{500}{1}$.
„ 43. *Hemialus dissimilis*, n. sp., Gr. and St., $\frac{400}{1}$.
„ 44. „ *amplectans*, var. *major*, Gr. and St., $\frac{400}{1}$.
„ 45. „ *tenuicornis*, Grev., view of valves in conjunction, $\frac{400}{1}$.
„ 46. *Trinacria simulacrum*, n. sp., Gr. and St., $\frac{400}{1}$.
„ 47. „ *ventricosa*, Gr. and St., frustular view, $\frac{500}{1}$.
„ 48. *Melosira oamaruensis*, n. sp., Gr. and St., under valve, $\frac{400}{1}$.
„ 49. „ „ „ „ upper valve, $\frac{400}{1}$.
„ 50. *Pyxilla reticulata*, n. sp., Gr. and St., $\frac{750}{1}$.

PLATE XIV.

„ 51. *Biddulphia punctata*, Grev., frustule, $\frac{350}{1}$.
„ 52. *Stoschia* (?) *punctata*, n. sp., Gr. and St., $\frac{250}{1}$.
„ 53. *Biddulphia lata*, n. sp., Gr. and St., $\frac{350}{1}$.
„ 54. *Porodiscus hirsutus*, n. sp., Gr. and St., $\frac{350}{1}$.
„ 55. *Huttonia virgata*, n. sp., Gr. and St., $\frac{600}{1}$.
„ 56. *Biddulphia tenera*, n. sp., Gr. and St., valvular view, $\frac{450}{1}$.
„ 57. „ „ „ „ frustular view, $\frac{450}{1}$.
„ 58. *Triceratium parallelum*, var. *gibbosa*, Gr. and St., $\frac{350}{1}$.
„ 59. *Anaulus subconstrictus*, n. sp., Gr. and St., valvular view, $\frac{450}{1}$.
„ 60. „ „ „ „ frustular view, $\frac{450}{1}$.
„ 61. *Triceratium eccentricum*, n. sp., Gr. and St., $\frac{500}{1}$.
„ 62. *Biddulphia reversa*, n. sp., Gr. and St., $\frac{500}{1}$.
„ 63. *Actinoptychus* (*undulatus*, Ehr., var. ?) *constrictus*, $\frac{500}{1}$.
„ 64. *Triceratium sexapartitum*, n. sp., Gr. and St., $\frac{500}{1}$.



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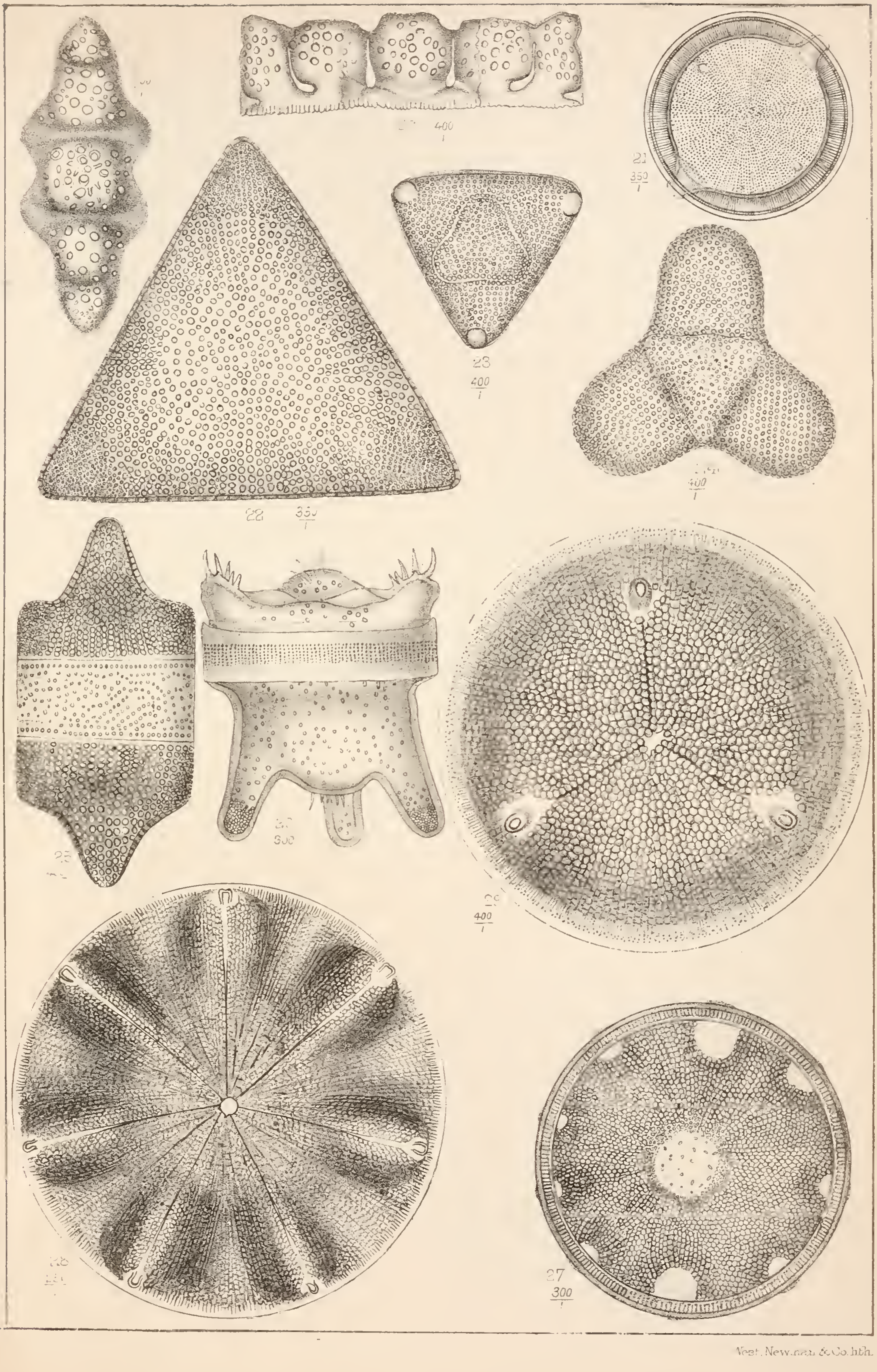

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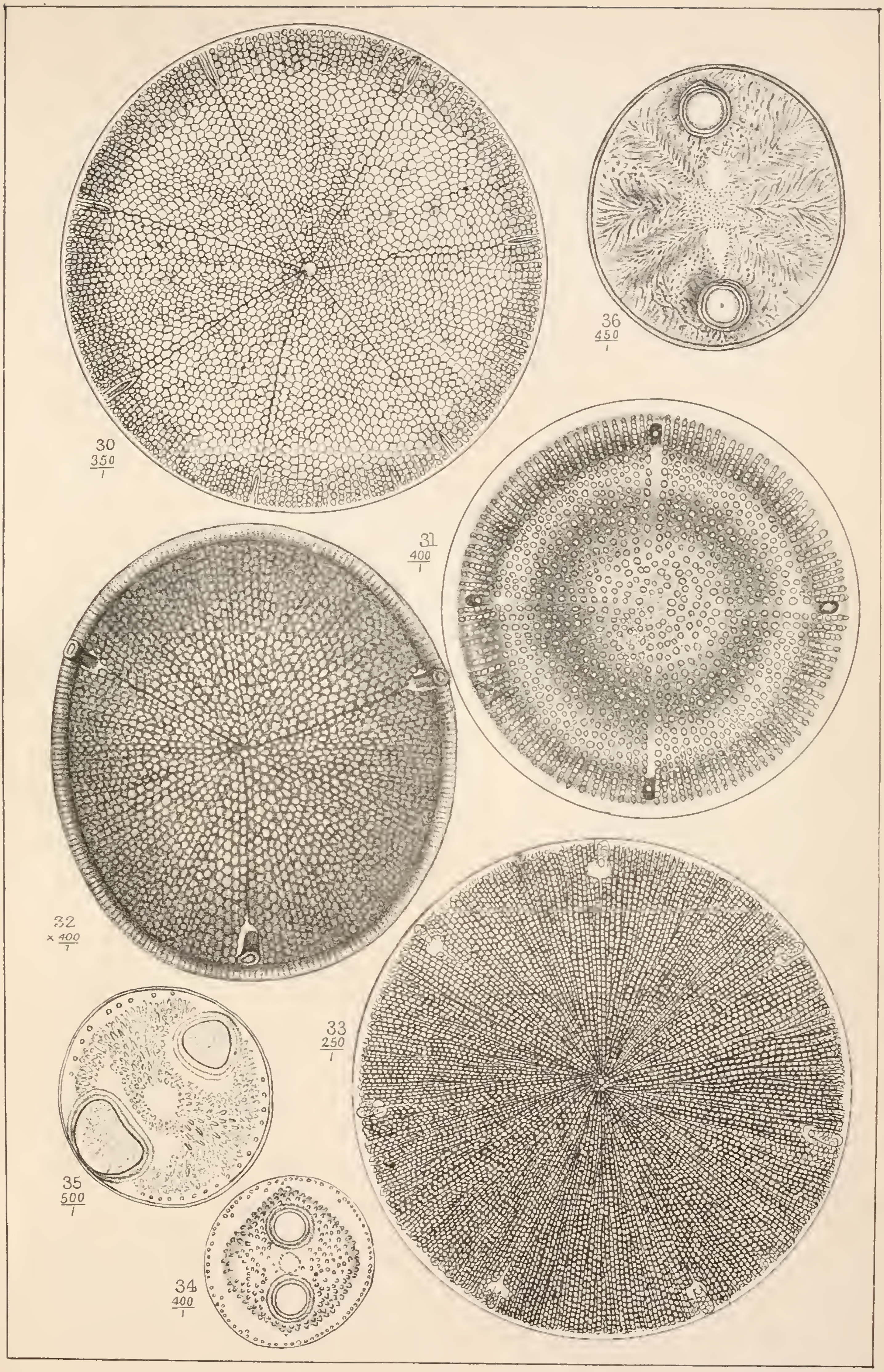

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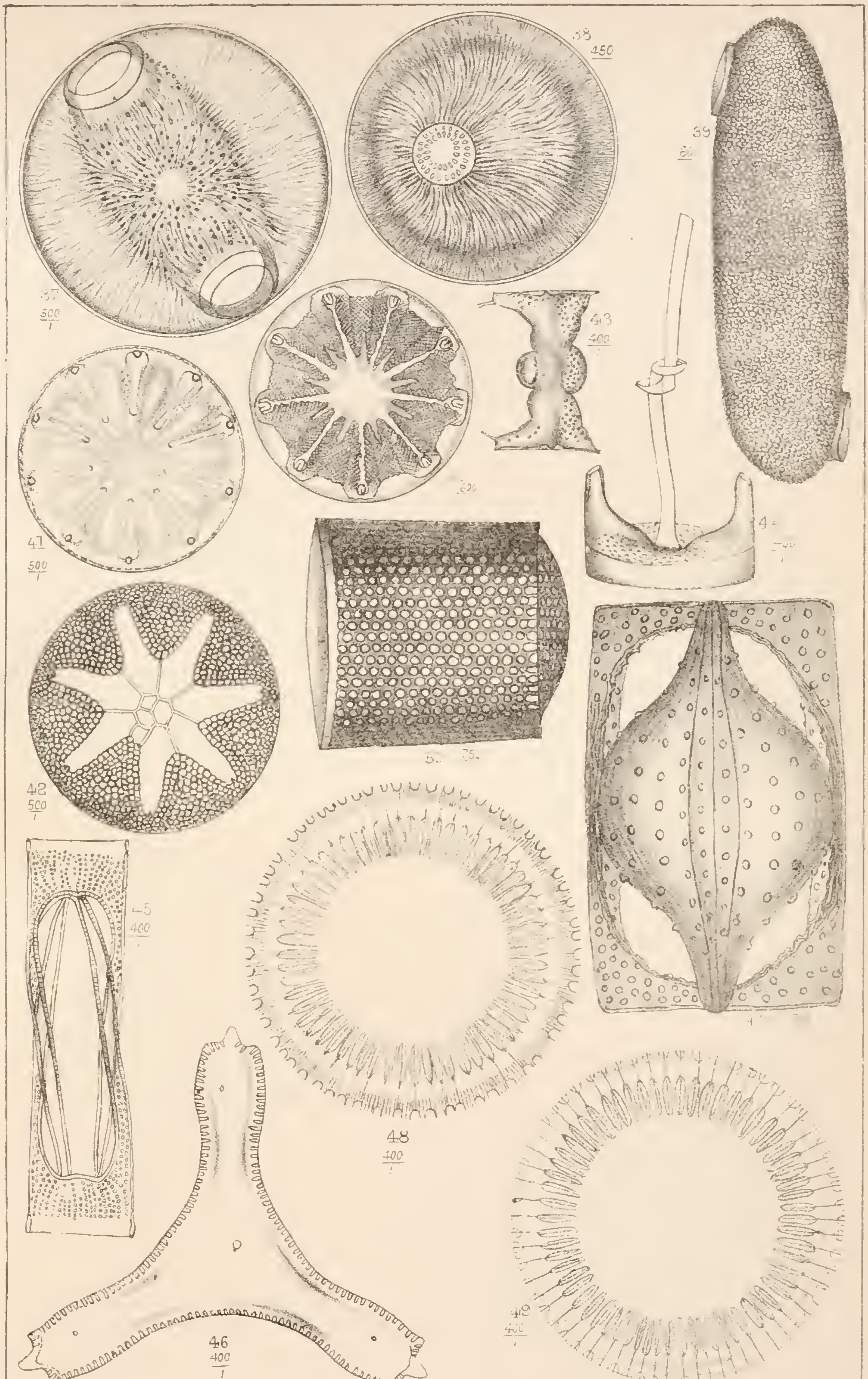

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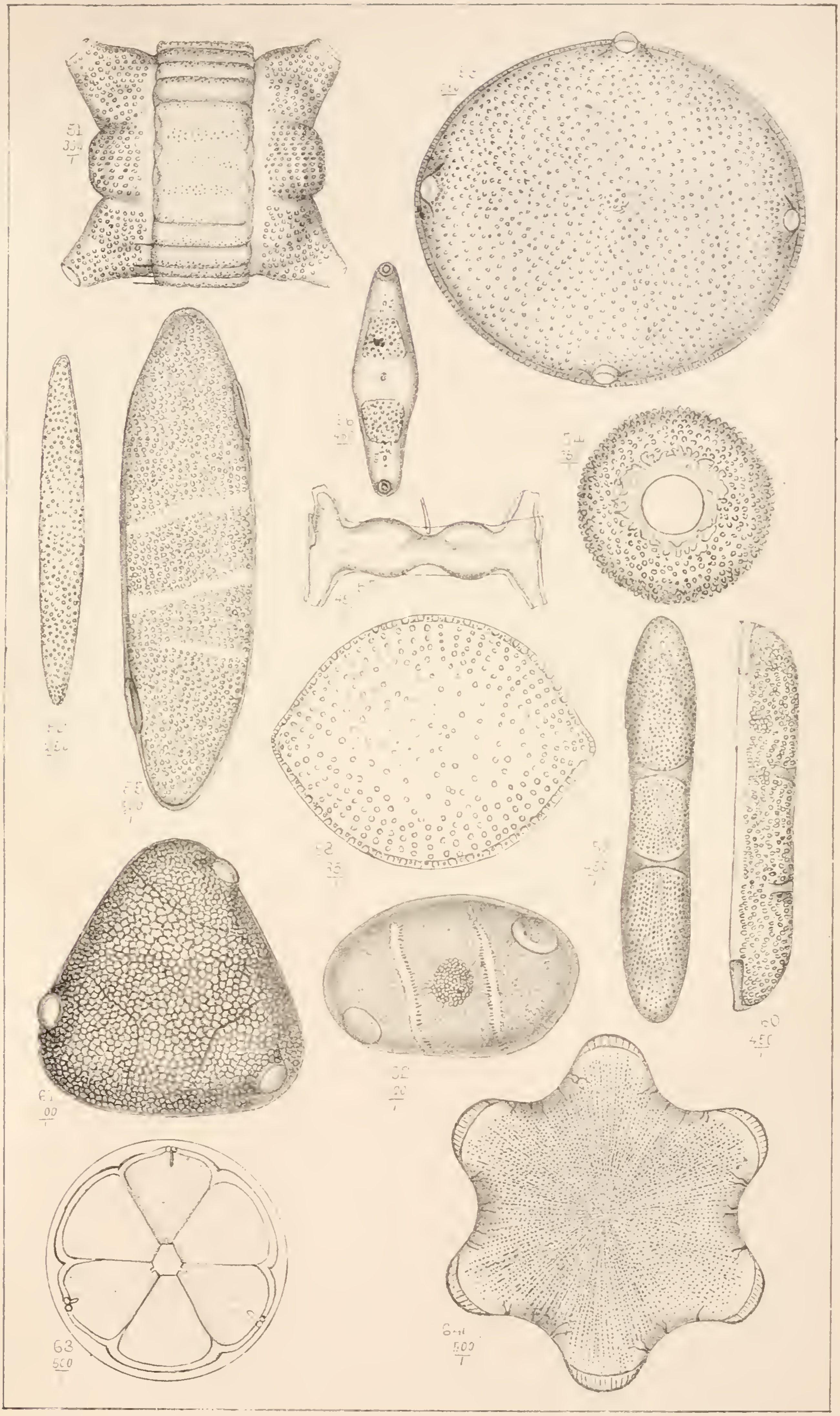

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List of Diatomaceæ Found in Loch Kinnord Kieselguhr, by the Rev. George Davidson, Minister of Logie-Coldstone, Dinnet, Aberdeenshire. (Extracted from "Trans. Edinburgh Geological Society.")

Recently a number of Diatomaceous deposits found in various parts of Scotland have been worked for commercial purposes, amongst other things in the manufacture of paper, the material being mixed with the ordinary pulp to give body and gloss. Most of the material which is called Diatomite, is very rich in Diatoms, that from Loch Quire deposit, for instance, containing as much as 88·732 per cent. That from Loch Kinnord, Aberdeenshire, has been carefully examined by Rev. George Davidson, of Logie-Coldstone, and, as a list of fresh-water forms in a readily procurable and easily cleaned material will no doubt be of interest to many microscopists, it is printed *in extenso* below. The original list is, moreover, quite out of print.

Epithemia turgida, Ktz.
,, *gibba*, Ktz.
,, *sorex*, Ktz.
,, *zebra*, Ehr.
,, *ocellata*, Ktz.
,, *gibberula*, Ktz.
,, *alpestris*, Ktz.
,, *ventricosa*, Ktz.
,, *Hyndmanii*, Sm.
,, *granulata*, Ktz.
,, *proboscidea*, Ktz.
,, *globifera*, Heib.
Eunotia arcus, var. *incisa*, Ehr.
,, *uncinata*, Ehr.
,, *gracilis*, Sm.
,, *major* Sm.
Eunotia impressa, var. *minor*, Grun.
,, *formica*, Ehr.
,, *nodosa*, Ehr.
,, *pectinalis*, Dillw.
,, *undulata*, Sm.
,, *tetraodon*, Ehr.
,, *ventricosa*.
,, *bigibba*, Greg.
,, *diadema*, Ehr.
,, *camelus*, Ehr.
,, *monodon*, Ehr.
,, *Faba*, Ehr.
,, *lunaris*, Breb.
,, *triodon*, Ehr.
,, sp. (?)

Cymbella Ehrenbergii, Ktz.
,, *cuspidata*, Ktz.
,, *Scotica.*
,, *hercynica*, Sch. Atlas, ix, 30, 31.
,, *pisciculus*, Greg.
,, *turgida*, Greg.
,, *naviculiformis*, Amd.
,, sp. (?) Atlas, ix, 56.
,, *obtusiuscula*, Ktz.
,, *augustata*, Grun.
,, *Norwegica*, Grun.
,, *acutiuscula*, Grun.
,, *æqualis*, Sm.
,, *(Navicula) Cesatii* (Rhab.).
,, *Anglica*, Lagerst.
Amphora ovalis, Ktz.
,, *lineata.*
Cocconeis placentula, Ehr.
,, *Helvetica*, Brun.
Achnanthidium flexellum, Breb.
,, *lanceolatum*, Breb.
,, *Jackii* (?).
Cyclotella operculata, Ktz.
,, *rotula*, Ktz.
,, *Kutzingiana*, Thw.
,, *papillosa*, O'Meara.
,, *antiqua*, Sm.
Surirella nobilis, Sm.
,, *splendida*, Ktz.
,, *linearis*, Sm.
,, *tenera*, Greg.
,, *constricta*, Ehr.
,, *craticula*, Ehr.
Tryblionella angustata, Sm.
Cymatopleura apiculata, Pritch.
,, *elliptica*, Breb.
Nitzschia augustata, Grun.
,, *denticula*, Grun.
Nitzschia linearis, Sm.
,, *sigmoidea*, Sm.
,, *parvula*, Sm.
Navicula divergens and vars., Sm.
,, *acuta*, Ktz.
,, *nodosa*, Ehr.
,, *stauroptera*, Grun.
,, *gibba*, Ktz.
,, *viridula*, Ehr.
,, *firma*, Ktz. and Grun.
,, *hebes*, Ralfs.
,, *mesotyla*, Ehr.
,, *lævissima*, Grun.
,, sp. (?) Atlas, 44, 51.
,, *nobilis*, Ktz.
,, *follis*, Ehr.
,, *rhomboides*, Ehr.
,, *amphioxys*, Ehr.
,, *major*, Ktz.
,, *mormonorum*, Atlas, 44, 24.
,, *dicephæa*, Ehr.
,, *var. stauroneiformis.*
,, *Brebissonii*, Rabh.
,, *viridula*, var. *major.*
,, *rupestris*, Grun.
,, *iridis*, Ehr.
,, *viridis*, Ktz.
,, *interrupta*, Ktz.
,, *cuspidata*, Ktz.
,, *augustata*, Sm.
,, *ovalis*, Sm.
,, *Americana*, Ehr.
,, *cocconeiformis*, Greg.
,, *serians*, Ktz.
,, *affinis*, Ehr.
,, *borealis*, Ehr.
,, *limosa*, Grun.
,, *radiosa*, Rabh.

Navicula cardinalis, Ehr.
,, *divergens*, var. *Mullensis*, Greg.
,, *semicruciata*, Ehr.
,, *gracillima*, Pritch.
,, *polyonea*, Breb.
,, *amphigomphus*, var., Atlas 49, 31.
,, *fulva*, Ehr.
,, *punctata*, Ehr.
,, sp. (?) Atlas, 44, 51.
,, *bacillum*, Ehr.
,, *stauroptera*, var., Grun.
,, sp. (?) Atlas, 43, 25
,, *pygmæa*, Ktz.
,, *scutelloides*, Sm.
,, *tumida*, Sm.
,, *acrosphæria*, Breb.
,, *Hitchcockii*, Ehr.
,, *Braunii*, Grun.
,, *inflata*, Ktz.
,, *leptogongyla*, Ehr.
,, sp. (?) Atlas, 45, 28.
,, *sphærophora*, Ktz.
,, *termitina*, Schm.
,, *commutata*, Schm.
,, *crassinervis*, Breb.
,, *exilis*, Grun.
,, *rhyncocephala*, Ktz.
,, *lacustris*, var. *β*. Greg.
,, *oculata*, Breb.
,, *mesolepta*, Ehr.
,, *amphirhynchus*, Ehr.
,, *Zellensis*, Grun.
,, *serians*, var. *minor*.
,, *hemiptera*, Ktz.
,, *undulata*, Greg.
,, *nodulosa*, Grun.
,, *stomatophora*, Grun.

Navicula rhombica, Greg.
Stauroneis phœnicenteron, Ehr.
,, *anceps*, Ehr.
,, *dubia*, Greg.
,, *acuta*, Sm.
,, *linearis*, Ehr.
Pleurosigma attenuatum, Sm.
,, *lacustre*, Sm.
,, *Spencerii*, Sm.
Synedra ulna, Ehr.
,, *biceps*, Ktz.
,, *capitata*, Ehr.
,, *lunaris*, Ehr.
,, *ladians*, Ktz.
,, *linearis*, Sm.
,, *longissima*, Sm.
,, *acus*, var. *tenuissima*, Ktz.
Cocconema lanceolatum, Ehr.
,, *cymbiforme*, Ehr.
,, *cistula*, Hemp.
,, *parvum*, Sm.
,, *Helveticum*, Grun.
Gomphonema acuminatum, Ehr.
,, *insigne*, Greg.
,, *dichotomum*, Ktz.
,, *constrictum*, Ehr.
,, *subtile*, Ehr.
,, *vibrio*, Ehr.
,, *Hebridense*, Greg.
,, *Brebissonii*, Grun.
,, *intricatum*, Ktz.
,, *turris*, Ehr.
,, *geminatum*, Ag.
,, *cygnus*, Ehr.
,, *tenellum*, Ktz.
,, *elongatum*, Grun.
Fragilaria capucina, Desm.
,, *lapponica*, Grun.
,, *virescens*, Ralfs.

Fragilaria var. exigua, Grun.
,, *construens*, Grun.
,, *undata*, Sm.
Tabellaria fenestrata, Lyngb.
Stenopterobia anceps, Grun.
Encyonema gracile, Rab.
,, *lunula*, Grun.
,, *cæspitosum*, Ktz.
Denticula tenuis, Ktz.
Denticula inflata, Sm.
Tetracyclus lacustris, Ralfs.
Melosira crenulata, Thw.
Campylodiscus noricus, Ehr.
Stephanodiscus minutulus, Grun
Odontidium mutabile, Sm.
Mastogloia Grevillei, Sm.
Ceratoneis arcus, Ktz.

PROCEEDINGS.

April 22nd, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. T. F. Smith was balloted for and duly elected a member of the Club.

The following donations were announced:—

"The American Naturalist"	In exchange.
"The American Monthly Microscopical Journal"	"
"The Journal of the New York Microscopical Society"	"
"Science Gossip"	From the Publisher.
Report of the Smithsonian Society	From the Society.
"Journal of the Royal Microscopical Society"	"
Report and Proceedings of the South London Microscopical and Natural History Society	"
Report and Proceedings of the Essex Natural History Society	"
"The Quarterly Journal of Microscopical Science"	Purchased.
Cooke's "British Desmids"	"
"Annals of Natural History"	"
"The Microtomist's Vade-Mecum"	"

The thanks of the Club were voted to the donors.

Mr. H. Morland read a paper "On Mounting Media, so far as related to Diatoms."

Mr. Stokes said he had tried one or two of the preparations mentioned by Mr. Morland, but so far as his experience went the unfortunate part was, that though it was easy to get a medium suitable in other respects, the difficulty was to keep it, because as a rule most of them had a great effect upon the cement, and after a time they were sure to get out. So far as he could see, dry mounts or Canada Balsam were the only kinds to be depended upon; with the others it was only a question of time—how long they would stand.

Mr. T. C. White said that he quite agreed with what Mr. Morland had said concerning styrax; he had tried it, and found that after a time it became granular. He had thought it might be a good plan to make a very dense solution of borax in glycerine, so thick as to be almost like a jelly, but he found that however well it answered at first, crystals were sure to form afterwards, and, of course, spoilt everything.

Professor Stewart said that in making a recent examination of a number

of Mr. Stephenson's slides, mounted in phosphorus dissolved in bisulphide of carbon, he found that there was nothing the matter with them, although many of them had been mounted as long as 12 years ago. Had there been any leakage there would, of course, have been a conflagration.

Mr. Sturt said he had tried, with success, a mixture of styrax and Canada Balsam, in which the *Aulacodisci*, *Triceratium favus*, and others, showed up splendidly. This medium would be found a very good one for a number of diatoms for which styrax alone was too highly refractive.

The President said he had some little experience of styrax as a mounting medium, although not as regarded the mounting of diatoms; but his impression was, from specimens which Dr. Gray had shown him, that when it was obtained in a pure state it was a very admirable medium for mounting a large proportion of diatoms. Dr. Gray had informed him that he actually boiled the styrax upon the slide with the diatoms in it, so that apparently the application of great heat did not always result in carbonizing. In his own experience he had found it unsuitable, because the objects which he desired to mount would not stand great heat, and on this account he had been obliged to abandon it, although he had hoped it might be of great use in mounting minute dissections of very clear chitinous objects, which were otherwise somewhat difficult to see. As regarded the material itself, there seemed to be no doubt that different samples varied in many respects to such an extent as to give an impression that there must be more than one species of plant from which it was obtained. One or two lots crystallized all over the slides, whilst others did not show much tendency towards crystallization; but from whatever cause this difference might arise, it seemed that the tendency to crystallize could be reduced to a minimum by macerating the styrax in a succession of warm waters; this was, however, too troublesome for most persons to carry out. The styrax which gave the crystals was much lighter in colour than the other kind, and on this account, if it could have been obtained free from them, it would have proved a more valuable medium. He had found that this light styrax was extremely difficult to dissolve in any medium which would take up a large quantity, so that when a mount did dry there was often very little of the resin left under the cover-glass, rendering it necessary to frequently run in more; and, on the whole, he found that it gave so much trouble that he had to abandon it altogether. He must say, however, that for diatom mounting where heat could be safely used it appeared to be a great advance upon Canada Balsam. In the matter of mounting with phosphorus, it was well known that Mr. Stephenson had been very successful, but it was undoubtedly very awkward stuff to handle by those who were inexperienced in the art of using it.

Mr. G. C. Karop read a translation of a paper from the German, relating to a Parasite infesting the Diatomaceæ. The subject appeared to him to be rather a new one, and, therefore, worth bringing before the Club, as it would be interesting to know if anything of the kind had been seen in this country. If those members who went to their excursions felt interested in the matter, he thought they might find the subject to be one which merited investigation.

Mr. Sturt said it was well to notice that the species seemed chiefly confined to *Synedra.*

The President thought the subject was one which might repay investigation, and expressed the thanks of the Club to Mr. Karop for translating the paper.

The President said there was one small subject which he had been requested to mention, and that was that some time ago a little alteration was made in the wording of the tickets which were placed beside the exhibits on the tables on their evenings of meeting. The alteration consisted of the addition of a line, in which gentlemen were requested to enter any points of special interest in their objects to which it was desired that attention should be directed. Some members used this and others did not, and the point he wished to urge upon them was that whenever they brought anything which was either new or of special interest, if they would kindly fill up the paper with a rather more detailed description than simply the name of the specimen, it would not only prove useful to other members present, but Mr. Hailes would be able to select such cases as might have special value for insertion in the Journal; and by this means a useful record might be preserved. As it was, a great deal of information was given in conversation which dropped out of their proceedings from the want of some means by which it might be recorded.

Mr. E. M. Nelson exhibited and described a new photo-micrographic apparatus.

Mr. T. C. White said he quite concurred with Mr. Nelson as to the advantage of having the whole of the apparatus mounted upon one base-board, because then whatever vibration took place it equally affected the whole of the apparatus, and so did not blur the picture. He should like to know from Mr. Nelson if, in addition to diatoms, he had tried any pathological sections, because these were what he found to be the most difficult class of subjects. There could be no doubt whatever as to the superiority of photography for the purpose of delineating objects, because however well a person might draw, it took far less time to photograph, and the details were sure to be entirely reliable. He took a photograph, a few days ago, in half an hour, which would have taken anyone at least a day to draw as minutely perfect as the picture came out.

Mr. Stokes asked if it answered better to increase the eyepiece power or to increase the distance from the eyepiece in order to obtain a greater increase in the size of the picture? Which would give the sharper print?

Mr. Nelson said he had as yet done nothing with the apparatus except diatoms, and of these he had only taken about two or three subjects. Until he succeeded in getting the finest detail which he could see or draw, he intended to go on with one thing; after this he hoped to do all sorts of other things beside. As regarded increase of size, it was Professor Abbé who said that where the distances could be obtained it was the lowest eyepiece which was the best to use.

A vote of thanks was returned to Mr. Nelson for his communication, and after announcements of meetings for the ensuing month had been made, the

proceedings terminated with the usual conversazione, and the following objects were exhibited :—

Melicerta conifera	Mr. F. W. Andrew.
Culex pipiens, ♂ & ♀, without pressure, showing muscular structure, &c. ...	Mr. F. Enock.
Fresh-water Diatoms from Mendip Hills, *Meridion circulare*, *Gomphonema Fragilaria*, &c., &c.	Mr. G. E. Mainland.
Eggs and Larvæ of Cat-Flea	Mr. C. Rousselet.

Attendance—Members, 44; Visitors, 2.

May 13th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Nostoc commune	Mr. F. W. Andrew.
Section of Human Retina...	Mr. E. Carr.
Diatoms, *Anthodiscus floreatus*, *&c.*, from Oamaru	Mr. C. G. Dunning.
Head of Queen Bee, *Apis mellifica*, with explanatory drawing	Mr. F. Enock.
Ova of Perch, embryo six days old	Mr. W. Goodwin.
Thick section of Gall, showing curious cellular tissue	Mr. G. C. Karop.
Diatoms from Florence (fresh water)	Mr. G. E. Mainland.
,, *Rutilaria tenuis*	Mr. H. Morland.
,, *Actinoptychus splendens*, in balsam, with ¼in. O.G. and Lieberkühn...	Mr. E. M. Nelson.
A Photo-micrograph of *Amphipleura pellucida* × 700 diam., taken with an oil immer. $\frac{1}{12}$ O.G., 1·43 N.A., and 3rd power projection eye-piece	,, ,,
Radiolaria. *Challengeron diodon*, and *C. Willemosii*, from a *Hyalonema* sponge	Mr. B. W. Priest.
Paludicella Ehrenbergii	Mr. C. Rousselet.
Diatom, *Myopsia mammosa*, from Oamaru ...	Mr. G. Sturt.
Type slide of Diatoms from Pensacola Bay, Florida	Mr. W. Watson.

Attendance—Members, 14; Visitors 2.

May 27th, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced :—

"Proceedings of the Canadian Institute" ...	In exchange.
"The Botanical Gazette"	,,
"The American Monthly Microscopical Journal"	,,
"The American Naturalist"	,,

"Proceedings of the Watford Natural History Society"		In exchange.
"Science Gossip"		"
"Annals of Natural History"		Purchased.
"British Desmids," concluding part		"

The Secretary read the following note from Col. O'Hara, accompanying a photograph of a worm found in a preparation of the poison of *Bungarus* :—

"Dear Sir,—In looking over some slides of snake poison, which I prepared in India, I find in one, in the clear poison of *Bungarus arcuatus*, or *ceruleus*, a parasitic worm, almost invisible by transmitted light. As it is a curious locality to choose for one's habitat, I send you a photo of it, by polarized light, which may interest the members of the Q. M. C. I send it unmounted."

The President remarked that it was certainly a very singular habitat for a parasite, because the *Bungarus* was well known as one of the most dangerous and poisonous of the Indian snakes, from 2,000 to 3,000 persons annually being killed by it.

Mr. H. M. J. Underhill gave a description of the anatomy of Spiders, illustrating the subject by means of diagrams, and numerous mounted preparations and sections exhibited under the microscopes provided for the purpose in the room.

Mr. B. T. Lowne regretted that he had unfortunately arrived too late to hear the whole of Mr. Underhill's paper, but with regard to the latter portion he should be very glad to have some further information, and should specially like to hear a little more in detail about the eyes. To mention one point, he should like to know whether Mr. Underhill had observed a distinct line of fibrous tissue separating the upper layer of cells from the layer of cells lying below ? He had himself paid some attention to these subjects, and had found the layers so separated in *Salticus*, but in some others it was absent. His own view was that this layer was a connective tissue layer separating the optic from the nervous portion of the eye.

Prof. C. Stewart said that Mr. Underhill had brought the views which he held so clearly and so fully before them that it was hardly necessary to supplement what he had said. In speaking, however, of the heart, he seemed to have had some difficulty in making out the valves, and, therefore, of explaining their action. He should himself have thought that they were the same as those of ordinary insects, and that their structure was as usually described in the text books, the organ consisting, in fact, of four chambers communicating with each other, before and behind, provided with valves. It was not so easy to see their action in all insects, but in the *Ephemera* they were seen very clearly. With the binocular microscope especially, an observer could see through the tissues and clearly watch the action of the pair of valves at each end, two of which guarded the orifice in front and two the orifice behind.

The President said he also had been struck with the observations of Mr. Underhill about the heart on account of the difficulty which he seemed to have met with in connection with the matter, and because his remarks ap-

peared to exclude the opinions of foreign arachnologists who had worked out the subject and had communicated the results. He remembered more particularly a paper by Prof. Claparède in which he described at some length the circulation and the structure of the heart, and illustrated the subject with figures, but the conclusions he came to were not the same as Mr. Underhill's. Prof. Claparède, on the contrary, thought there was both a forward and a backward aorta, and that the current divided at the heart, going partly backward and partly forward, though he thought the main current was the backward current. The observations upon which his conclusions were based were made on very young living spiders. He fancied that there was also a somewhat elaborate paper by Prof. Berkau on the same subject, in which he confirmed, on the whole, the observations of Prof. Claparède, but attributed the sucking action to the action of the trophi. A paper had also appeared by Prof. McLeod, of Louvain, on the sucking action of the *Arachnida*, in which he had drawn the whole thing with extreme skill, attributing the sucking action to the œsophagus and the sucking stomach. He remembered being considerably interested and pleased with this paper at the time he read it. He was not sure that he quite understood Mr. Underhill's remarks as to the movement of the blood cells in the lungs, but thought he seemed to take the different laminæ to be entirely detached organs. In the same paper to which he had referred Prof. McLeod had described the pillars joining the different gills, and had figured them rather carefully. He remembered that when he saw Mr. Campbell's specimens and sections of spider's lungs, they came to the same conclusion that there was some connection between the laminæ, but they could not quite decide whether they were pillars or not—this was prior to the appearance of Mr McLeod's paper, though he did not think Mr. Campbell had ever published anything upon the subject.

Mr. Underhill said that Mr. Lowne had just looked at his specimen and found that the fibrous separating layer of the eye was not present in it. The diagram was not taken from the eye of an *Epeira*, but from some other species, and he had not cut any sections of the eyes of *Salticus*. As regarded the circulation of the blood, he did not wish to contradict Prof. Claparède, whose paper on the subject he had not seen, but, of course, if he said he had seen it go in both directions, no doubt it did so. It was, however, very difficult to see, and it was possible that a mistake might be made from seeing it apparently moving in both ways, so that anyone looking at it in one direction would see it moving both ways, though there was really only a backward current. The movement of the heart was very clearly seen in spiders, the pulsations going along the heart like waves. As to the valves, he was quite aware of what the text books said about them, but that constituted his difficulty, because he could not find them, although he would not say positively that there were none. The salivary glands were situated one in each jaw. The gills were attached at one end, but were free at the other end, and were not quite free at the sides. As for the pillars which the President mentioned having seen, he could not help thinking that some small hairs must have been mistaken for pillars, or else the sections which

he examined were imperfect; if an improper section was taken these would be likely to appear to be pillars.

A vote of thanks to Mr. Underhill for his paper was then proposed by the President and carried unanimously.

A paper by Mr. B. T. Lowne was, owing to the lateness of the hour, deferred until the next meeting.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, when the following objects were exhibited in illustration of Mr. Underhill's paper under a series of microscopes provided by Mr. C. Baker and other members:—

Section of *Lycosa*, showing brain, heart, gills, liver, silk glands, &c.
Small spider, unnamed.
Eyes of *Lycosa*.
Section of eye of *Lycosa*, showing lens, vitreous body, and retina.
Spinnerets of Hair Curler Spider, *Ciniflo similis*.
Threads of *Ciniflo*.
Spinnerets of *Clubiona*, showing silk tubes.
Nest of spider, *Theridion*.
Calamistrum or "comb" on hind leg of *Ciniflo*.
Foot of Web-walking Spider, *Epëira*.
Foot of Ground-walking Spider, *Dysdera*.

Attendance—Members, 39; Visitors, 5.

June 10th, 1887.—Conversational Meeting.

The following objects were exhibited:—

Diatoms, *Biddulphia Baileyii*	Mr. F. W. Andrew.
" *Kittonia elaborata*	Mr. H. Morland.
Bacillus tuberculatus, with new cheap German $\frac{1}{7}$ O.G. N.A. 84	Mr. E. M. Nelson.
Type slide of Oamaru diatoms, mounted by Herr Kniker	Mr. G. Sturt.
Section of Retina, showing rods, cones, &c. ...	Mr. W. Watson.

Attendance—Members, 24; Visitors, 0.

June 24th, 1887.—Ordinary Meeting.

Chas. Stewart, Esq., F.L.S., &c., Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. Francis W. White and Mr. William Thos. Wilson.

The following donations were announced:—

A Series of Papers	From the Royal Dublin Society.
"Proceedings of the Belgian Microscopical Society" ...	From the Society.
"Journal of the R.M.S."	" "
"The Botanical Gazette"	In exchange.

"Proceedings of the Natural History Society of Glasgow" } In exchange.
"Annals of Natural History" ... Purchased.

Professor B. T. Lowne gave a *résumé* of his paper "On the structure of the head of the Blowfly larva, and its relations to that of the perfect insect," which he illustrated by diagrams drawn upon the black-board as he proceeded, apologising, however, for the absence of other diagrams which he had not yet been able to complete.

The Chairman was sure that the members would agree with him that they were not only greatly indebted to Mr. Lowne for bringing this subject before them, but also for not having brought up his series of diagrams, because a diagram drawn upon the board, and developed as the speaker proceeded, illustrated a subject far better than could be done by pointing to a complicated diagram. Mr. Lowne had made the view which he took of the matter so plain that he was quite sure it would be clearly understood by all who had listened to it, and he should be glad to hear any remarks from anyone present upon this "object of the microscope," than which few were more interesting or more common. He thought he understood Mr. Lowne to say that what was commonly spoken of as the tongue—or hypo-pharynx—of the cricket or the cockroach was not actually homologous, but was *serially* homologous to the proboscis of the blowfly.

Professor Lowne said this was so; though functionally the same, the two organs were developed from different parts.

Mr. Tebbs said he should like to ask Mr. Lowne how it was that in the gnat the labium appeared to be quite a complete and independent organ? In *Bombylius* they had them also quite separate, and in the sucking flies the same thing also occurred. In tracing them down it was found that the lancets became less developed until, in the blowfly, they were enclosed in the labium. Mr. Lowne seemed to have been taking an extreme case without bringing into relation with it the intermediate stages. In the bee there was a complete set of maxillæ, and so on down to the extreme case of the blowfly where they had no function.

Professor Lowne thought it would be admitted that if he was right in the case of the blowfly the correctness of his view in connection with all the other flies would necessarily follow. He thought that in the case of the gnat and of *Bombylius*, the parts referred to by Mr. Tebbs were the modified galea of the maxillæ. In *Asilus* the labium was clearly distinct from the lips of the proboscis. In *Tabanus* the whole of the structures were so modified that he was puzzled as to what was the actual condition; he had, however, no doubt that in the proboscis they had the galea. In the bees, the tongue was a perfectly distinct structure, and there was no doubt in his mind that it was a labium. With regard to the lancets they might go on discussing the subject, but without conclusive results until they knew what they were developed from. They had been called mandibles, but he entirely dissented from that view, thinking it far more likely that they were paraglossæ. It was certain, however, that there was no other means of finding out what they were except by tracing out their development.

A vote of thanks to Professor Lowne for his admirable paper was proposed by the Chairman, and unanimously carried.

Mr. T. F. Smith read his paper "On Diatom Structure," which he illustrated by a number of choice specimens, exhibited under microscopes in the room.

The Chairman said that the criticisms which Mr. Smith had offered in the course of his paper were no doubt quite capable of being answered by those whose views had been opposed. Diatom structure was undoubtedly extremely complicated, and where, as in these cases, the conditions of observation gave rise to questions of considerable difficulty, they naturally led to differences of opinion, which were by no means lessened by the way which people had of seeing what they wanted to see.

Mr. E. M. Nelson thought they had enjoyed a great treat that evening by having a diatom paper from a new source; to him, certainly, it was a great pleasure to welcome a new worker in a field which was admittedly so surrounded with difficulties. To get a proper notion of diatom structure was important from a botanical point of view, but not less so as affording the means of determining the correct interpretation of microscopic images, because in all cases they were met with questions of dioptric difficulty. They had far too few workers in this very interesting and important field. As to his remarks upon *Asteromphalus*, Mr. Smith was perfectly right to criticise the paper as he had done, because it was certainly misleading on account of its not being clearly stated that it intentionally dealt with the finer structure only. The writers were perfectly conversant with the eye-spots, but did not render this plain, and the matter was further complicated by the wording of the paper, which ought really to have had the second paper tacked on to it. He did not wonder, therefore, that Mr. Smith thought they had gone wrong. The specimen which Mr. Smith was showing under the name of *Coscinodiscus centralis* was really not *centralis*, but *conscinus*, a totally different form from *centralis*, in which the bar cuts right through the middle. The next one was quite new to him. The next was an extremely beautiful specimen of *Triceratium*, and he thought he might say it was the finest he had ever seen; they were quite agreed as to the structure of this. In *Aulacodiscus Kittonii* he had seen the eye-spots, and he should be happy to show Mr. Smith anything which he had, and to work out the subject together for the good of science. The diatom namers seemed to go rather by the shapes than by structural differences; the slide of *centralis* which he had was one which had been very carefully and independently named. Personally he felt very much obliged to Mr. Smith for his paper, and for the many beautiful specimens with which he had illustrated it.

Mr. Morland said he had been looking at some of Mr. Smith's slides, and could say that the one called *centralis* was really *Coscinodiscus biangulatus*; it was so called because where the edges turned over there were two angles formed; *centralis* was much finer. It would be found in Smith's "Atlas of the Diatomaceæ," and also in "Castracane on the 'Challenger' diatoms."

Mr. Karop said he was very pleased indeed to have heard Mr. Smith's paper, which was one which ought to give rise to a good deal of discussion.

He thought Mr. Smith went wrong in arguing from analogy in such cases where one of the difficulties met with was the fact that personal equation was sure to come in, and where that was so he supposed it was scarcely possible to get people entirely to agree.

Mr. Smith said, with regard to his having thought that Mr. Nelson and Mr. Karop knew nothing about the matter, he was misled by the letterpress, which went on to say that the diatoms consisted of one siliceous membrane. As to the naming of *centralis*, he had gone by his general knowledge, and of the many specimens which he had examined in no case had he found a bar as described by Mr. Nelson. He got a specimen some time ago which had been mounted by Wheeler, but which he had found too thick for his purpose; he, therefore, got another slide by another mounter, and found that as regarded species it was precisely the same. As regarded *Kittonii*, the matter was one which he could not at present solve, and he thought it was only by analogy that it could be solved.

The thanks of the Society were unanimously voted to Mr. Smith for his paper, and for the exhibition of the specimens in illustration.

Announcements of meetings and excursions for the ensuing month were then made, and the proceedings terminated with the usual conversazione, when the following objects were exhibited by Mr. Smith in illustration of his paper:—

Coscinodiscus asteromphalos, in section, bits chipped out of centre.

Coscinodiscus centralis, showing finer structure, and little bosses at corners of hexagon.

Coscinodiscus, sp., from Richmond, Virginia; with broken edge membrane showing over edge of hexagon.

Aulacodiscus Kittonii, showing eye-spots and hexagons.

Triceratium, sp., from Hungary, showing fine membrane torn off portions of hexagons.

Triceratium, sp., from Oamaru deposit, showing broken membrane over hexagons.

Coscinodiscus, sp., from Jutland, showing membrane in eye-spot.

Coscinodiscus, sp., from Oamaru deposit, with granulated membrane in place of eye-spot.

The following objects were also exhibited:—

Rivularia articulata	Mr. F. W. Andrew.
Section of garden spider, *Epiera diadema*, showing the internal anatomy, with an explanatory drawing	Mr. F. Enock.
Mounted Rotifer, *Limnias ceratophylli* ♀	Mr. W. Watson.

Attendance—Members, 36; Visitors, 5.

On Diatom Structure.

By T. F. Smith.

(*Read July 22nd*, 1887.)

Plate XV.

It will be within the recollection of the members of this Club that when I exhibited here last month what was presumed by me to be *Coscinodiscus centralis* I was met, on the authority of Mr. Morland, with the objection that it was not *Coscinodiscus centralis* at all, but *concinnus* or, I think, *angulatus*. I did not at the time profess to have knowledge enough of the species of diatoms to decide that question, and even if I had done so the principal point would still remain doubtful, whether the diatom figured by Messrs. Nelson and Karop and that exhibited by myself were identical.

Since then Mr. Morland has given me a slide, mounted by himself, which he considered was *Coscinodiscus centralis*, and Mr. Sturt has lent me the slide from which Mr. Karop's drawing was made, and I am now in a position to state that, whatever may be the names of the two specimens, they certainly are not the same, and the structure is altogether different. Having stated this fact, my surmises about their having mistaken one structure for another and focussing through the wrong side of the diatom, falls to the ground, and I now beg to express my regret to these gentlemen for challenging their reading of the structure before making quite sure that we were not speaking about different diatoms.

I am now, however, in a position to speak with certainty about the specimens I show to-night and theirs being identical; and, having examined them carefully, I am still of opinion that the perforated membrane in Messrs. Nelson and Karop's drawing is shown on the wrong side of the hexagons. There is no question this time of focussing from the wrong side of the diatom, but, I think, of taking too deep a focus and of failing to take note of what was outside before the image disappeared. I find it very easy to get the appearance shown in the figure, and it would be easy to sit down half a dozen times and rise up again from the microscope

without suspecting it not to be the true structure. It is no reflection, therefore, on these gentlemen's skill that they have produced this appearance; but there is an evolution of a knowledge of structure as well as an evolution of structure, and it has taken me a matter of nine months to arrive at my present ideas of the structure of the diatom in question. This diatom was perfectly familiar to me in appearance, although not in name, and I have spent many hours in trying to spell out the meaning of the appearance it presents, but it is only lately, after a study of fractured specimens, that I am able to remain satisfied with my reading. Having convinced myself. it now remains for me to try to convince others, and for that purpose I have two specimens of *Coscinodiscus centralis* here to-night, one being from the slide given me by Mr. Morland and the other from a spread slide of the Nottingham Deposit, mounted and lent me by Mr. Cole.

I have also endeavoured to draw the structure that you may know what to look for, and decide for yourselves whether it is correct when identifying it under the microscopes. In Pl. XIV., figure 1 shows the centre of the disc, and is supposed to be seen with the outer membrane removed and looking down on the inner layer of eye-spots. Figure 2 shows the outer perforated membrane, the relation of the different parts of which I will try to point out on the black-board. In doing this I am obliged to make a more symmetrical arrangement than what is seen in the diatom, to conceal my want of skill in drawing. The hexagons in the specimens seem to be thrown together anyhow, but when I also drew them anyhow and tried to put on the superstructure the result was deplorable. You draw first your hexagons and then place a round dot at each corner large enough to conceal the junction. These dots represent the unperforated part of the outer membrane, and form a ring of six on the top of each hexagon. Now draw another circle in the centre of each ring of dots, bring down a star-like point from the circumference of each dot to the outer edge of the inner ring, and the membrane is complete. There are indications of the centre circle having two or three perforations like those shown by Messrs. Nelson and Karop, but I have not put them in my drawing as it would tend to confuse the structure. Figure 3 in my drawing shows a part of the disc with four or five of the hexagons torn out of the centre, and Figure 4 the same part with some of the outer membrane remaining projecting over the space from which the

hexagons are wanting. I am sorry to say this last drawing is as bad as can be, and fails altogether to convey the appearance of the torn structure under the microscope. That part in the microscope can be readily seen from its being paler, proving that the dark colour of the ring of spots is due to the hexagons ordinarily underneath. This is all I have to say about this diatom to-night, but there are other appearances that I have lately seen that I have not embodied in this paper because they are new to me, and I am not sure how far they are true. I shall be pleased, however, if the members will look at it for me and give me their opinions.

There now remain two little matters connected with my last paper that I should like to mention. The first is my opinion that the figure of *Aulacodiscus cellulosus* given in the Journal by Messrs. Grove and Sturt confirmed my views of the structure of *Aulacodiscus Kittonii*, although I had not examined it. Since then Mr. Sturt has kindly lent me the slide, and I find the structure is exactly what I said it would be, viz., an inner layer of eye-spots, with hexagons stuck on the top, and an outer perforated membrane on the top of the hexagons.

Secondly, I exhibited a *Coscinodiscus* with an outer perforated membrane, stuck on the top of the spines which project one from each corner of the hexagons. The specimen was a fractured one, and did not show the membrane all over, but my reason for choosing it was that it showed the broken edge of the membrane projecting over the hexagons. One gentleman that night could not conceive a membrane being in that position, and thought it was part of another diatom slipped on to the one I was showing. I tried to convince him that it was not so, but don't think I succeeded. Since then I have had a conversation with Mr. Morland on the subject, and find that he also is sceptical and puts down the appearance to a granulation of the medium in which the diatoms are mounted. I may state that some time ago I had a bit of a brush with Mr. Morland in the "English Mechanic" on the existence of a structureless membrane on the inner side of *Arachnoidiscus*, and must admit that in that encounter I came off second best, and this, I suppose, is what makes him think I am again in error. Both these objections are perfectly legitimate ones, and having advanced my opinions it is my duty to prove my case. To do this I have brought the same slide to-night, and am fortunate enough to have here specimens not far from each other, one showing the broken

edge of the membrane and the other with it over the whole diatom. This, I hope, will satisfy both class of objectors, as it meets the points of each.

EXPLANATION OF PLATE XV.

Fig. 1. *Coscinodiscus centralis.* Central part. Outer membrane supposed to be removed.
„ 2. Same diatom. Outer membrane only.
„ 3. Same diatom fragment. Inner layer only, with piece torn out of centre.
„ 4. Same as Fig. 3, with torn outer membrane projecting over cavity underneath.

Object glass used, Swift and Son's $\frac{1}{12}$ inch oil immersion and D. eyepiece. Magnification about 1,400 diameters.

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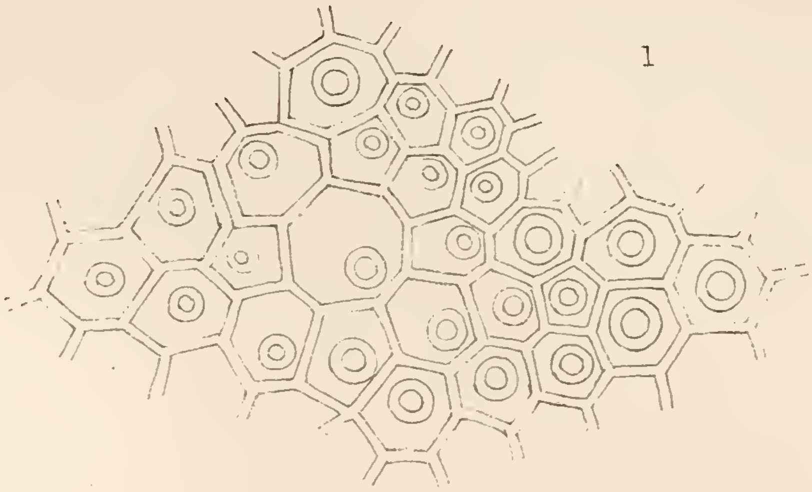

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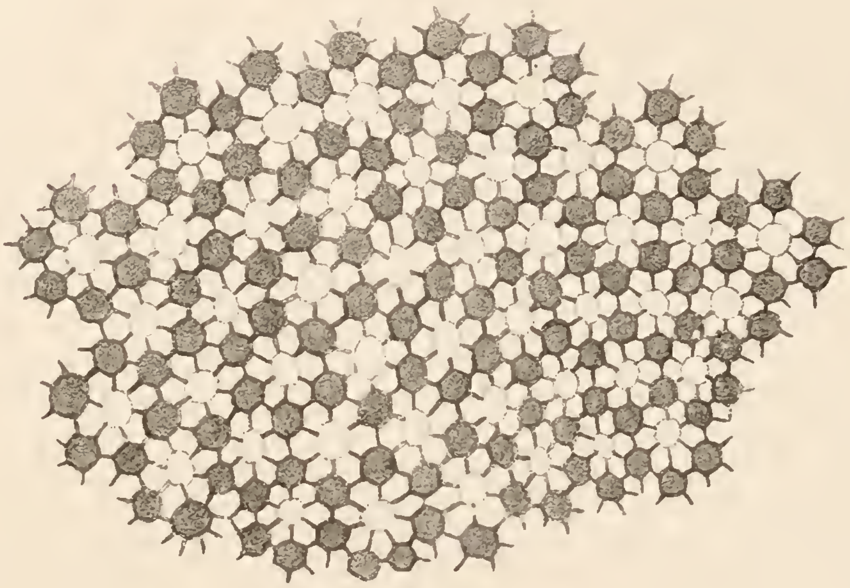

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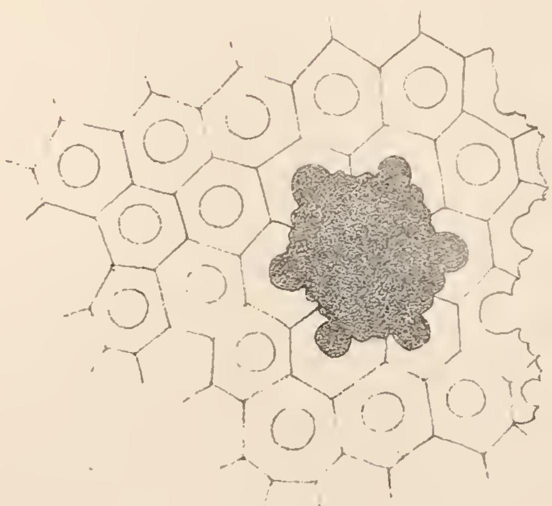

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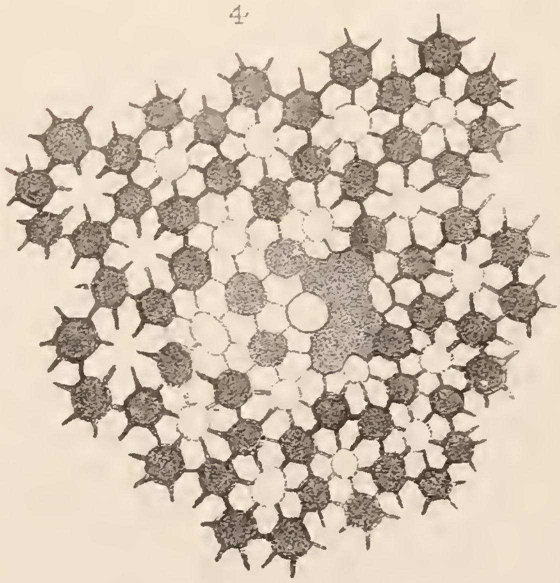


T. F. Smith del West, Newman & Co. lith

Do Porodiscus interruptus and Craspedoporus elegans belong both to one Form?

By H. Morland.

(*Read July 22nd*, 1887.)

Last gossip night I exhibited a slide containing specimens of *Porodiscus interruptus* and *Craspedoporus elegans*, two new species of diatoms described and figured by Messrs. Grove and Sturt in the third part of their paper on the marine diatomaceous deposit from Oamaru, New Zealand.

In the centre of this slide was a frustule, on one side of which was a valve of *P. interruptus*, and on the other, one of *Craspedoporus elegans*. I am sorry to say that as yet I have only found one such frustule, and thinking it quite possible that one valve might have got jammed into the hoop or "connecting zone" of another valve, I deemed it advisable to examine this frustule critically before finally mounting it, as in consequence of having but one such specimen I could only show it in one position. First I decided upon mounting it showing "side" view, as in such position the two valves could readily be recognized by focussing first on the upper valve and then downwards on to the lower one. Having come to this decision, all that remained for me to do was to examine the "front" view of this frustule, which I had to do "dry," and under a $\frac{1}{4}$-inch objective (285 diameters); as far as I could judge, it was a true frustule. However, I still further tested it by passing it in and out of a drop of water (necessary for freeing it from adherent sand and fragments), and found it behaved exactly the same as I have found other frustules to behave; but whilst examining it in this manner I had to do so under a lower power, a $\frac{2}{3}$-inch, of about 60 diameters.

The valves of both these forms, roughly speaking, are shaped somewhat like a watch-glass; in the frustule their convex sides both point one way, *Porodiscus interruptus* having the convex side outwards, and *Craspedoporus elegans* having the same side towards the interior. Arguing from analogy only, I should be inclined to

think that this diatom is, or was, a parasitic form, growing somewhat after the manner of the *Cocconideæ*, *Craspedoporus elegans* being underneath.

As tending to confirm my observations of this frustule, I may add that since I mounted it I have found a valve of *Craspedoporus elegans* with the " connecting zone " still attached, the same being on the convex side of the valve, in a similar relative position as in the frustule.

Should other diatomists examining this deposit be so fortunate as to find frustules of these forms, either confirming or refuting my views, I shall be glad if they will favour this Club with information respecting the same. As, however, these forms are scarce, it is possible we may have to wait some time before receiving such information; when valves are scarce, perfect frustules are still scarcer.

The present is, I think, a good example of how difficult it is to correctly describe a fossil diatom when the same is not represented by living specimens. The Oamaru deposit, from which I obtained my specimen, contains also another diatom, of which the frustule has dissimilar valves. I refer to *Trinacria ventricosa*. At first sight these valves would be considered as belonging to totally different species, but, fortunately, as this form is rather common in the deposit, complete frustules, with the two dissimilar valves *in situ*, are to be found without much difficulty.

Notes on a Species of Orthezia found in Kew Gardens.

By Edward T. Browne.

(Read August 26th, 1887.)

Plates XVI., XVII.

At the Conversational Meeting of the Club in July I had the pleasure of exhibiting an insect which I had found in the Economic House, Kew Gardens.

I labelled the insect at the meeting "A supposed *Dorthesia*, allied to the Aphis and the Coccus," obtaining this information from Westwood's "Introduction to the Classification of Insects." On page 450, Vol. ii, he writes:—

"In *Dorthesia* the antennæ of the male are very long, but simple, and the abdomen terminated by a thick pencil of very delicate white setæ; and the female is covered with elongated flakes of a waxy secretion, which, in some exotic species in my collection, are nearly an inch long. I possess males belonging to the genus *Dorthesia*, the wings of which are nearly an inch in expansion."

In the insect-room at South Kensington Natural History Museum, I found several species of the genus *Orthezia*, but they all slightly differ from the one I obtained at Kew.

From the inquiries I have made there is no doubt about the insect being an *Orthezia*, and I believe it is a new species.

There is a slight confusion about the name of the genus. In Westwood it is written *Dorthesia*, but by later writers *Orthezia*; the latter form is correct, for the genus is named after l'Abbe d'Orthez; and by an error the d' was joined to the word Orthez, making it Dorthez.

The genus *Orthezia* is closely allied to the Aphis and the Coccus; it is a true plant-louse, and found in many parts of the world.

There is not much difficulty in observing the habits of these creatures. I kept some in a cork-cell, without food, for over three

weeks. Two females, after having spent three weeks in a cork-cell, were chloroformed, and mounted as dry objects. I was greatly surprised, on looking at the slide a week afterwards, to find one of the females alive, and twenty young *Orthezia*, all alive and doing well.

The *Orthezia* which I am exhibiting to-night were first seen about twelve months ago, on a *Strobilanthes*, a Chinese plant, which has been in the Economic House about three years.

The insects have gradually been spreading, in spite of measures taken to annihilate them. Now they may be found on *Scutellaria*, and other foreign plants in the adjoining house. A peculiarity of the genus *Orthezia* is the secretion of wax. Round the body there is a waxen fringe, and the females possess a large egg-pouch, or marsupium, which grows gradually from the extremity of the abdomen. The eggs are laid inside the marsupium, and their number increases in proportion to the size of the pouch.

By this arrangement the eggs furthest from the abdomen are the first laid, and, consequently, first hatched. At the extremity of the marsupium, on the upper surface, there is an opening, through which the young *Orthezia* crawl.

In some specimens only a very small opening exists at the extremity of the marsupium, not large enough for the young to crawl through. When this occurs I find a square opening is made near the abdominal end of the marsupium, but I cannot say how this opening is made; to all appearance it looks as if it were broken, or gnawed.

On opening the marsupium the eggs and the young *Orthezia* are seen. The eggs, when first laid, are white, but afterwards become light brown. They are wrapped up in fine waxen fibres, resembling cotton-wool. In a good-sized marsupium about 20 eggs may be found, together with several young.

The young *Orthezia* are scarcely visible to the naked eye, and they spend their early days in the marsupium, using it as a place of protection. Often they may be seen crawling about their mother, and when danger threatens they crawl inside the pouch.

When young, there is a slight fringe of wax round their bodies, and a few waxen tufts on the middle of their backs.

I saw a young one go through the process of changing its skin.

The old skin splits along the back, and then the young one gradually backs itself out.

The males possess wings, and are destitute of the waxen covering. In Westwood's "Introduction to the Classification of Insects," Vol. i, Plate I, there is an engraving of the male of *Orthezia cataphractus*. The male I found at Kew (caught flying about near the food plant) differs considerably from the one figured in Westwood. The insect is much smaller, and there are only two waxen threads from the extremity of the abdomen. In *Orthezia cataphractus* there is a large bunch.

Mr. Douglas, who has written several papers on *Orthezia*, which may be found in the Entomological Society's Transactions for 1881, states that the larvæ of males of *Orthezia urticæ* are like those of the females in form, and are only distinguished from the females by two projecting posterior laminæ.

I have not yet discovered this form of the male among the Kew species. I have shut up separately many *Orthezia*, without the marsupium, in hopes of discovering a male, but within a fortnight the marsupium has begun to form.

At the end of the third week my insects have generally died of starvation, as I am unable to obtain food for them.

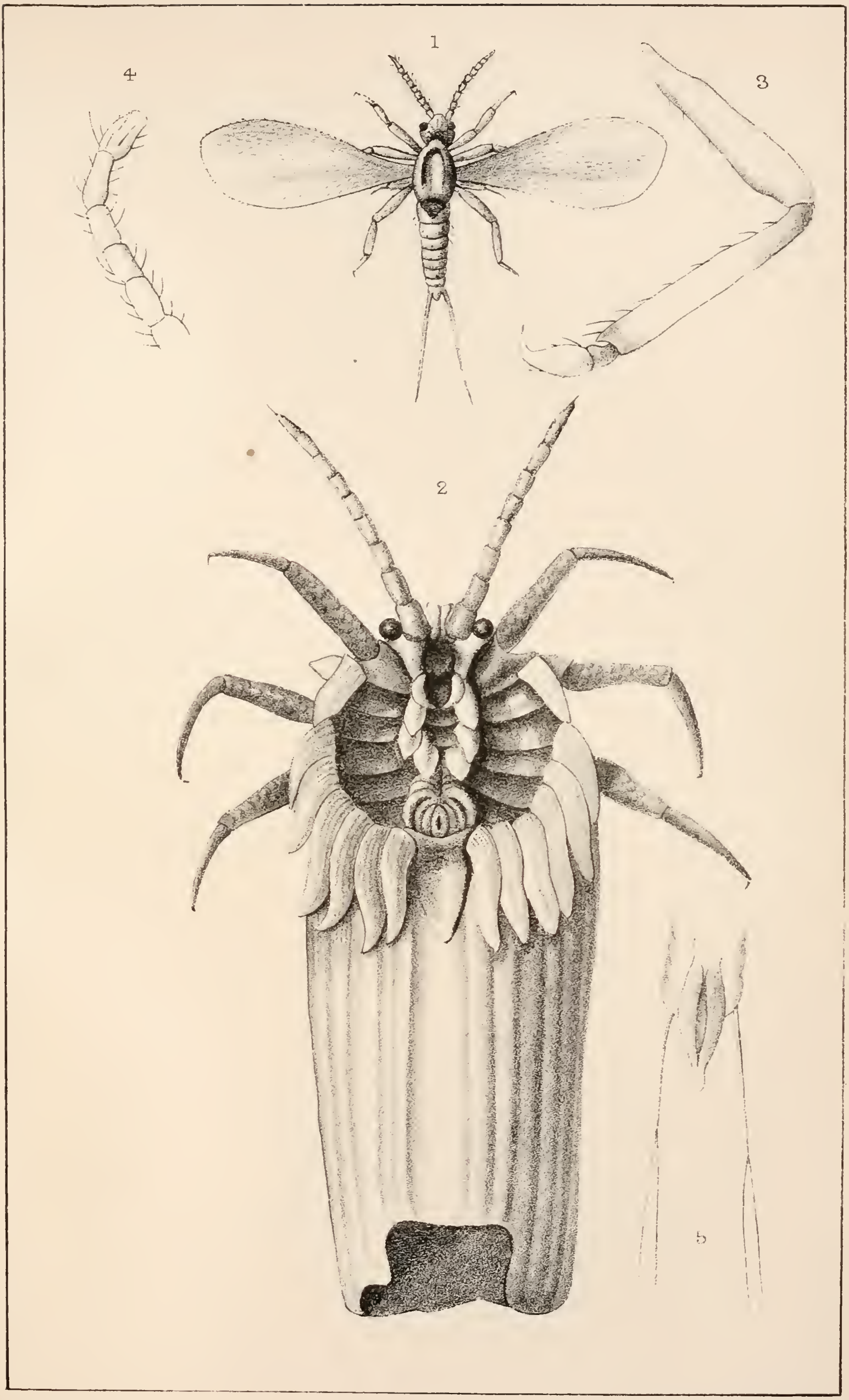
During the past eight weeks I have seen many dozens of young *Orthezia* born, but not a single winged male has made its appearance. Probably the *Orthezicæ*, following the custom of their relations, the Aphides, produce all females for many generations. I must express my thanks to Mr. J. W. Douglas for his kind response to my inquiries, and I shall take the liberty to quote from his kind letter the valuable information contained in it. He says: "I am greatly obliged to you for the *Orthezia*; it appears to me to be quite new, but I am not sure that the absence of lamellæ on the thorax is normal, for all of them in the tube are more or less broken. I have stated all I know about *Orthezia* in the Entomological Society's Transactions, and previously in the 'Entomologists' Monthly Magazine.' There is one species (American, Walker) that I do not know, and there is one species figured by Cornstock, in his report for 1880, which is not yours." It is my intention to forward more specimens to Mr. Douglas, as he possesses better means of identifying the insect than I do. I also feel much indebted to Mr. S. J. McIntire for the help he has given me in collecting specimens.

PLATE XVI.

FIG. 1. *Orthezia insignis,* male, × 30 diam.
„ 2. „ „ female, × 30 diam.
„ 3. Leg of male, × 125 diam.
„ 4. Tips of antenna of male, × 125 diam.
„ 5. End of abdomen of male, showing double setæ, × 125 diam.

PLATE XVII.

FIG. 6. Female *Orthezia*, waxy secretion removed by soaking in benzole, × 30 diam.
„ 7. Under side of same, × 30 diam.
„ 8. Marsupium of female laid open and showing eggs and young *in situ*, × 30 diam.



Henry F. Hailes del West, Newman & Co lith.

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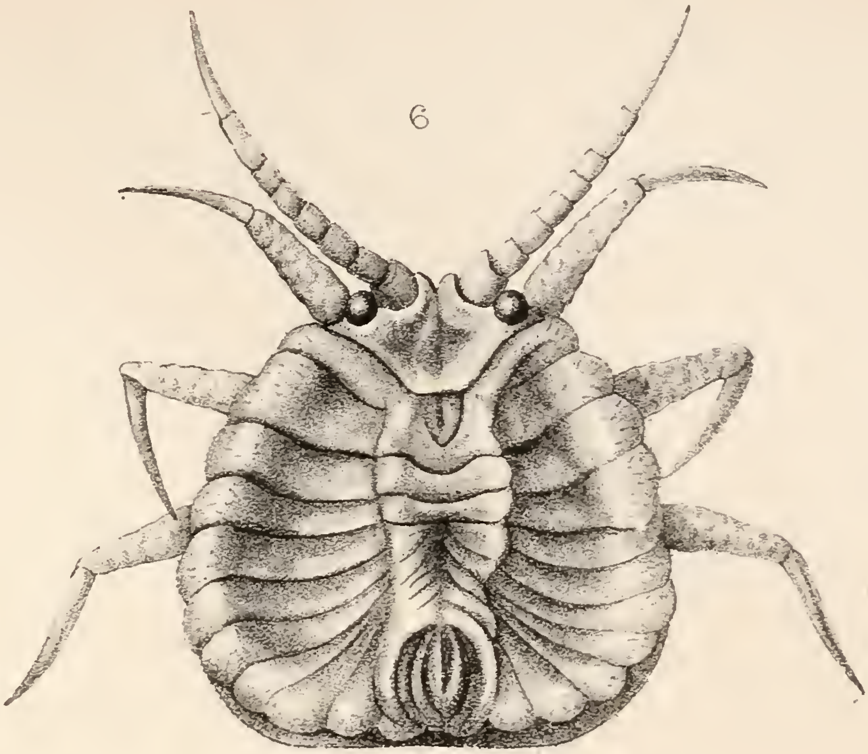

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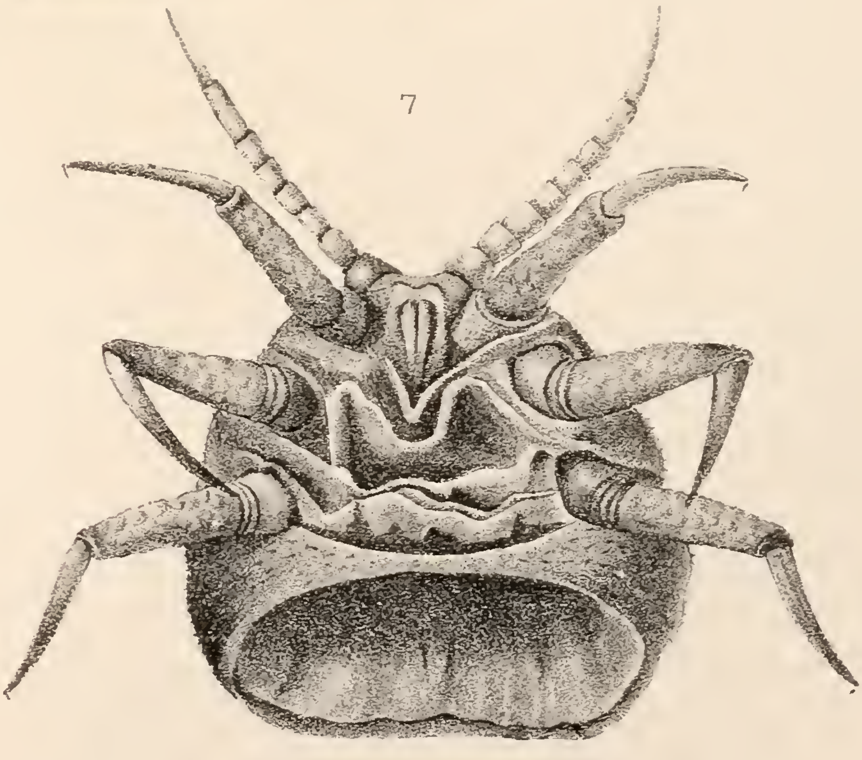


Henry F. Hailes del. West, Newman & Co. lith.

On a New Eye-Piece.

By E. M. Nelson.

(Read October 28th, 1887.)

Having given for some time past a good deal of attention to eye-pieces for telescopes as well as microscopes, and having lately contrived one which has surpassed any I have yet seen in the sharpness of its defining power, I thought a short account of it would prove of interest to the Club.

Until lately there have been among microscopists only two kinds of eye-pieces in general use—the Huyghenian and the Kellner, but a little while ago Professor Abbé introduced what are known as compensating eye-pieces. Of these three forms the Kellner may be dismissed by saying that although it possesses one achromatic lens its defining power is undoubtedly bad. The compensating eye-pieces, while being absolutely necessary to some of the apochromatic series of objectives and beneficial to others, improve the definition of ordinary objectives.

With regard to all my previous work with achromatic singles, doublets, and triplets, &c., I may say that I have not succeeded in producing any combination giving definition equal to the Huyghenian. But the increased definition obtained by the compensating series caused me to re-open my investigations.

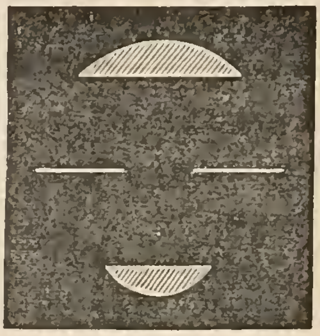
The action of the Huyghenian eye-piece is that of an under-corrected lens balancing an over-corrected image ; the strange thing is that the compensating system of eye-pieces, being all over-corrected, should give better results. After going into the matter I came to the conclusion that the Huyghenian system sacrifices definition to flatness of field, this latter quality being one in which the compensating eye-pieces are eminently deficient. Now we know that a single convex lens having the least aberration has its radii 6 : 1, and the outstanding aberration is $\delta f = -\frac{15}{14}\frac{y^2}{f}$.

But the aberration of a plane convex is not much greater if the plane side is to the focus as $\delta f = -\frac{7}{6}\frac{y^2}{f}$, but if the convex side is towards the focus δf becomes $= -\frac{9}{2}\frac{y^2}{f}$, or about four times as much.

This is in illustration of what I have frequently urged, viz., that every microscopist should *see* aberration by making images of a lamp flame on a piece of paper with the field lens of one of his low eye-pieces, turning first the convex and then the plane side to the focal point on the paper.

Another very instructive experiment is the reading of a micro-photograph of printed matter with a plano-convex lens, reversing the lens and noticing the effect.

Fig. 6.



With the convex side to the photograph the printed matter is quite misty, and the field is fairly flat, but with the plane side the field is very much curved, and the print in the centre of the field becomes black, the fog going off. I therefore thought that if I reversed the eye-lens of the Huyghenian eye-piece (see Fig. 6) I should get increased definition at the expense of flatness of field. Nor was I disappointed, for I found on trial that I got material increase of sharpness in the centre of the field, the margin being quite out of focus.

This out of focus part I stopped out by making the diaphragm smaller, so reducing the size of the field from 16in. to 8in., which leaves it still larger than that given by the compensating ones, and quite large enough for all practical purposes.

Therefore, if anyone is desirous of improving the definition of his eye-pieces, all that is necessary is the inversion of the eye-lens and the contraction of the diaphragm. Of course it is only advisable to treat eye-pieces of less than 1in. focus in this manner, as a large flat field is of paramount importance with the lower eye-pieces, and the loss of definition is not so apparent. The best result I have obtained with this plan is by achromatizing the eye-lens. The one which I have here to-night is the best eye-piece I have ever seen. It is of 12 power, and gives sharper pictures than one of Zeiss' compensating series of the same power, which was carefully selected from several sets. This eye-piece works perfectly with the 24 mm. and 3 mm. Zeiss apochromatic objectives. You will notice there are only two surfaces to work in the simple form and four in the achromatic form, against seven in the compensating eye-piece.

On a Small Portable Binocular Microscope and a Live Box.

By C. Rousselet.

(*Read October 28th*, 1887.)

I have been asked to bring before you a small microscope which has been made to my order.

I have long felt the want of a portable binocular for the purpose of showing objects effectively when away from home, here at our meetings for instance, without having to carry the very heavy weight of the large instruments. The portable monocular microscope did not, as a rule, allow me to exhibit objects to my satisfaction, as a certain class of them are seen to so much greater advantage with the binocular.

Several forms of portable binocular have been made by various makers, but they are mostly very elaborate, and consequently very expensive. My aim has been to have it as simple as possible without sacrificing any of its essential qualities; the result is here before you, and I may state that it certainly gives me every satisfaction. There is necessarily a great deal about it that is old, and I will therefore confine my remarks to a few of its principal points.

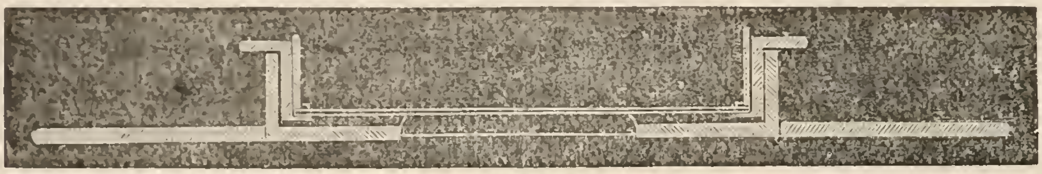
The foot is the well-known sliding tripod; the total length of the tubes is eight inches, which is as short as they could be made without causing a strain to the eyes; the diameter of the tubes is only a little over one inch, but the tubes carrying the eye-pieces are wider at the top, and receive the B eye-pieces of my large microscope; this is of importance, because with small eyepieces the field of view is greatly reduced, and the result is not so satisfactory. The stage is simple, and has a broad but *very thin* sliding-stage, which moves very smoothly. The condenser, also, belonging to my large microscope fits in an adapter, which is screwed on to the stage below, and it is focussed by a spiral motion, which brings it up just above the stage if required.

There is no tail-piece, the mirror being carried by a double-jointed arm fixed at one corner of the stage, which allows it to be brought above the stage for the illumination of opaque objects; for

this purpose the concave mirror has a very short focus ($1\frac{1}{2}$in.), and acts as a very effective silver side-reflector. The focussing is effected by a good coarse rack-work ; a fine adjustment was not required for my purpose, as I can work very well with a $\frac{1}{4}$in. objective without it, but it could be added if thought desirable. The stand is very light, but sufficiently steady for all practical purposes.

The whole is packed into a small case, which, when quite complete, weighs just under 6lbs.

Fig. 7.



I have also to bring to your notice a live box which has been made to my order, which for pond life certainly works better than any other contrivance of the kind I have seen. The old live box, which has done duty for so long, has the very great defect that the object placed thereon is totally out of reach of the substage condenser, and, therefore, incapable of being properly illuminated.

Some years ago Mr. Swift made an improvement by fixing the glass plate, on which the object is placed, nearly flush with the plate of the live box, as is shown in the above woodcut (Fig. 7). But this, however, introduced another defect, that was, that any objects placed in the box could be examined, over the whole field, only with low powers, whilst with high powers only those objects placed near the centre could be reached. Now, it is very frequently desirable to examine an object with a high power after it has been found with a low one, and we all know how very fond living creatures are of getting to the edge of the drop of water in which they are placed, and to shift them to the centre is frequently a very tedious work, and is often fatal to the animal.

To remedy this defect, I have had a live box constructed in which the glass tablet is somewhat reduced in diameter, but the outer ring is enlarged sufficiently to allow any high power to focus to the very edge of the glass tablet, and the result is very satisfactory. An object lying anywhere in the live box can be reached by the condenser from below, and by both low and high powers from above; besides which, it acts as a very good compressor, capable of fixing, without hurting, the smallest rotifers, and, when you know how to

do it, it is also possible to get a rotifer in so small a drop of water that it is unable to swim out of the field of view of a quarter inch objective. I have had it in constant use for animals of all sizes, from the smallest infusoria to tadpoles, and I hope it will be found equally useful to my fellow pond-hunters.

I have also a small screw compressor, made on the same principle; it is very simple, and effective, and allows of regulating the pressure to a nicety.

On the Finer Structure of Butterfly and Moth Scales.

By T. F. Smith.

(Read October 28th, 1887.)

At the last Conversational Meeting of this Club I exhibited the scales of *Amathusia Horsfeldii* as showing the villi figured by Dr. Royston-Pigott in the "English Mechanic."

Allow me to say here that I know nothing about butterflies beyond recognizing one when I see it flying, and then I am not sure it is not a moth. But we are all familiar with the appearance of the scales, and that, under suitable powers, they nearly all present the same general appearance—longitudinal and cross-ribbings. But this is only in a certain focus; in changing the focus the whole appearance alters, and the field becomes filled with dots. I know nothing more unsatisfactory than to rise up from the microscope in a state of fog and feel that you are no nearer to a knowledge of the structure than when you sat down. This, however, was the condition of my own mind until very lately, and I have no doubt it is also the condition of many other observers.

The battle of the scales was fought out very fiercely about a dozen years ago, when Dr. Royston-Pigott claimed to have discovered beading in *Podura* and *Lepisma* scales, and, although very little is heard of the matter now, it is not because it was settled, but because the combatants ceased from sheer exhaustion. On the *Podura* scales I have never detected the slightest appearance of beading, but the other day, on *Lepisma* scales, I came across the exact appearance figured in the ninth volume of the "Monthly Microscopical Journal," and I have not the slightest hesitation in asserting, first, that the appearance as shown in Fig. 4 of Plate 11 of that volume is faithfully portrayed, and, secondly, that it is false. It is well to know sometimes where a reputation was wrecked, and I beg leave to show you on the blackboard how it happened.

It is pretty well known that most insect scales are formed by two membranes, sometimes plain and sometimes corrugated, and that in the *Lepisma* the two corrugated membranes cross each other at an angle, giving it the appearance of spines. In addition to that there are very fine cross-ribbings, the same as on most butterfly scales, but except in some of the smaller scales are nearly all torn and hang about in all directions. If you imagine a lady's antimacassar with long, plain bands from end to end, and most of the cross stitches between them torn, you will have the appearance presented by one of the membranes of the *Lepisma* scale. The other corrugated membrane crosses this one at an oblique angle, and where any part of the fine cross-ribbings cross the oblique markings there is the appearance of beads. Dr. Pigott claimed these beads as a proof of the advancing definition of object glasses, and within certain limits he was right, but it required the definition of the oil immersion to complete the evidence.

But while there is a boldness in asserting the presence of a certain structure on imperfect evidence, there is also a boldness of denial, and this is exemplified in a paper read before the Royal Microscopical Society in about 1874, by Mr. McIntire, on butterfly scales, in which he correctly figures the beading or villi, but calls it pseudo-beading. I am afraid, however, it cannot be explained in this manner, as microscopical ghosts will rise from anywhere they are conjured up, but on butterfly or moths scales will rise from one side only, proving to me that they have a real presence. This small beading will rise on the surface of nearly all the scales I have examined, but it is impossible to connect them with the cross-ribs in the finer ones, even with the widest-angled oil immersion, but in the scales of the *Amathusia* they are plainly seen to stand on them, and the structure is large enough to remove all doubt. As nearly all scales present the same primary structure, is it a very far-fetched conclusion to arrive at, that the fine beading of the minute scales is fastened on in the same manner, even if you cannot see the connection?

The scales of *Amathusia* are very interesting from their connection with historical microscopy. On the 20th of December, 1848, Mr. Warren De La Rue read a paper before the Microscopical Society on the scales of this butterfly, in which he mentions and draws the beading as seen by him on the cross-ribs. Illustrating the paper is a fine plate showing the whole scale magnified 800

diameters, and on another plate a part of the same scale magnified 1,900 diameters, and drawn from that to a further scale of 4,400 to 1. I don't know a better object than the more magnified drawing, with which to measure the progress that has been made since that date, with even dry objectives. The drawing shows the structure as shown by Ross' $\frac{1}{12}''$ objective, considered at that time and for a long time after a king of glasses, but does not show the villi, although "an irregular net-like covering" was apparent to the observer, which he set down as pigment cells. To-night I show the same object under a dry $\frac{1}{6}''$, just made for me by Swift and Son, and of which the new optical glass forms a component part. For the purpose of comparison with the drawing I have forced up the glass to 1,900 diameters, and the villi are there seen plainly standing up from the crossbars.

The scales of *Amathusia* are mounted dry, but the three other scales which I show are mounted in Canada balsam, and I am indebted for them to Mr Hinton, of Varley Road, Upper Holloway, without whose aid I could not have shown the structure to-night. By this method all here is plain, while a scale mounted dry will give only the barest indications.

Allow me here to give my ideas of the structure of the different scales shown under the four microscopes. On the first stand is the *Amathusia*, which gives the key to all the others, and the structure in this I will try to show you on the blackboard. It is very simple; longitudinal ribs running from end to end of the scale; cross-ribs at regular intervals, and rising from these two or three beads, some of which seem to stand close on the cross-ribs and some to rise from them with a stalk. On the second stand is a coarse reticulated scale of *Morpho menelaus*, and I want to call your attention to the contrast between the coarseness of the main structure and the beautiful minute beads with which it is outlined.

On the third stand is a scale of *Papilio memnon*, and nothing can exceed the beauty of its structure. Instead of a single crossbar at regular intervals connecting the long ones, they are connected by a beautiful interlacing pattern, from which rises numerous minute filaments not more than the 100,000th of an inch in diameter. On the fourth stand is the scale of a moth (*Zygæna trigonilla*), and here the structure is quite different. I can see no trace of cross-ribbing, but from the inner part of the membranes of the scale, I think, a tufted structure springs, which, in

appearance, is not unlike the hairs on the leaves of some plants. The scale is somewhat rounded in section, and this internal growth seems to be the means of keeping the two membranes apart.

With regard to pigment cells, I do not think there are any, as I have never been able to trace any such between the two membranes. Dr. Pigott, in last Friday's "Mechanic," like Silas Wegg, "drops into poetry" and says, "All pigment is pure figment," and in this I agree with him. In conclusion, I beg to say that I am not wedded to any opinions expressed in this paper, but am ready to change them on receipt of evidence. I have not had the time to become master of all the facts, and no doubt will have to modify some of my opinions on further investigation.

On the Histology of the Muscles of the Fly and their Relation to the Muscles of Vertebrates.

By B. Thompson Lowne, F.R.C.S., Lecturer on Physiology in the Middlesex Hospital Medical School, &c.

(*Read November 25th*, 1887.)

Our knowledge of the comparative histology of muscles has been much retarded by the fact that authors have been slow to recognize that the striated muscles of different forms of animal differ greatly from each other. Thus the blow-fly exhibits three distinct types of striated muscle, two of which differ materially from the ordinary striated muscles of the mammalia.

In mammals three forms of muscles are well known, non-striated muscle, heart muscle, and striated muscle. With the first of these the present paper is not concerned; the two last exhibit transverse striation. In heart muscle, the nuclei are situated in the centre of the fibre, and there is no investing sheath or sarcolemma, whilst in the skeletal muscles there is a distinct elastic investing sheath to each fibre, and the nuclei are placed immediately beneath it.

A transverse section of such a skeletal muscle fibre shows that it consists of a number of prismatic columns, surrounded by an intercolumnar substance; thus the section is mapped out into irregular fields, fields of Cohnheim.* The transverse sections of the columns when highly magnified appear dotted with minute highly refractive points. This appearance has been differently interpreted by different observers; Schwann† demonstrated the existence of moniliform fibrillæ, and I am inclined to regard these bright points as the sections of the ultimate moniliform fibrillæ of Schwann. The moniliform fibrillæ are cemented together into prismatic rods or fibrils by an interfibrillar cement material; the fibrillæ are the muscle rods of authors, and form the principal or contractile substance, whilst the cementing medium is the intermediate substance (Zwischen-substanz) of Rollett.‡ The columns of united moniliform fibrillæ are the "colonnettes" of Viallaines,§

* Virchow's Archiv., Bd. 34.

† Stricker, "Comp. Histology," Vol. iii.

‡ Stricker, *l.c.*

§ "Ann. Sc. Nat. Zool.," 6th ser., Tom. 14.

the intermediary substance between the columns forming the line or boundaries of Cohnheim's fields is muscle plasma, and is continuous with the nucleated layer immediately within the sarcolemma.

I regard the muscle fibres of the heart as colonnettes, the transverse section of a single fibre representing a large field of Cohnheim.

The above view of a muscle fibre appears to be borne out by a comparative study of the three forms of striated muscle fibre which exist in the blow-fly and other insects, and I should describe a striated muscle fibre as consisting of one or more columns of primitive fibrillæ cemented together, forming one or more colonnettes. In the ordinary mammalian muscle fibre a number of colonnettes are embedded in a nucleated plasma, and surrounded by a muscle-sheath.

All the varieties of striated muscle in the fly possess the above characters, but it is only in the larva that the fibres correspond with those of the mammalia, in which numerous colonnettes are embedded in plasma, and surrounded by a membranous sheath, sarcolemma, with the nuclei of the plasma immediately beneath it.

It is noteworthy that the muscles which we might be tempted to regard as the most highly differentiated form of contractile tissue exist only in the insect in its larval condition, when development is but little advanced above the vermiform type.

Physiologically, the muscles of the larva of the fly have, however, the same functions as in the higher vertebrata; they contract powerfully, and the duration of the contraction is comparatively long; fatigue does not supervene rapidly. Such muscles respond to a second stimulation immediately after contraction, and the contraction is tetanic, not clonic.

With regard to the ultimate structure of the colonnettes, or bundles of ultimate fibrillæ, the optical appearances differ much, according to the method of illumination and the kind of objective used. It is easy to make out alternate dark and light bands. With my immersion $\frac{1}{16}$, the bright bands, in specimens fixed with osmic acid, appear very narrow and well defined, and the dark bands appear to consist of dark prisms, separated from each other by very fine bright lines running in the direction of the fibre; but with a quarter, and the same illumination, the dark and light transverse bands change places with each other, the bright bands becoming

diffused and broad, whilst the dark bands become narrow, and minute bright dots appear in a line in the centre of the dark band.

Such appearances indicate, to my mind, difraction phenomena, and are not inconsistent with the structure which I have indicated above, the transverse striæ arising either from the moniliform condition of the primitive fibrillæ, or from an alternation of more and less highly refractive material in the fibril itself.

In the imago of the fly two totally distinct forms of muscle exist, which possess well-marked histological characters differentiating them from the muscles of the larval insect. These two forms of muscle were recognized by Dr. Weismann,* by myself,† and more recently by M. Viallaines.‡ They have been distinguished by the last-named author as the muscles of the wings and the muscles of the limbs. Neither term is very fortunate, however. All the muscles of the imago, including those which move the wings, except in the vibratory movement of flight, belong to the second kind; I shall, therefore, speak of them as the ordinary muscles of the imago, and I shall designate the first kind as the muscles of flight.

The muscles of flight occupy the greater part of the thorax. They consist, as M. Viallaines § has pointed out, of enormously enlarged colonnettes, and are entirely devoid of any investing sheath. In transverse section each muscle consists of a few gigantic fields of Cohnheim, each dotted over with a regular and close punctation of minute highly-refracting granules. In optical longitudinal section each fibre is seen to consist of very fine more or less distinctly beaded fibrillæ, embedded in a ground substance of low refractive power, in which rows of very small oval nuclei are distributed.

The ultimate fibrillæ exhibit alternate dark and light bands, which may be regarded, perhaps, as the expression of the moniliform character of the fibres, or possibly of an alternation of substance; for although the beading of the fibres is often distinct, in other specimens it is not recognizable.

M. Ranvier|| believes the fibrillæ of the wing muscles are capable of still further subdivision. I am unable to determine that such a

* Weismann, "Zeitsch für ration Med.," Bd. xv., p. 60.
† "Anatomy of the Blowfly," 1870, London.
‡ *L.c.*
§ *L.c.*
|| "Leçon d'Anatomie General sur le System Musculaire," Paris, 1880.

division can be effected, but if it can it does not show that the fibrils are not morphological elements of the tissue; they are perfectly distinct, and are sufficiently separated by the interfibrillar ground substance to be clearly differentiated with the highest powers in thin sections.

Physiologically, these muscles are distinctly differentiated from all other forms of muscle tissue; their contraction is vibratile, and corresponds to artificial incomplete tetanus. That is, their contraction may be described as consisting of a prolonged series of single contractions, like those of heart muscle, but with a refractory or fatigue period of extremely short duration. If we regard the interfibrillar material as nutrient material, its abundance between the contractile fibres is explained in relation to the physiological properties of the muscle.

The last type of muscle which I shall describe is the ordinary muscle of the imago.

These differ from the muscles of the larva in consisting of a single hollow colonnette; the cavity is an axial canal, which encloses a row of nuclei. The fibre is further provided with a more or less distinct investing sheath or myolemma.

In transverse section such fibres exhibit the same appearances as a field of Cohnheim. The nuclear canal, however, sends off stellate cracks in many preparations, which partially separate it into segments.

As with the primitive colonnettes of the larval muscle, optical longitudinal sections give variable appearances. I will not decide whether the fibre is divided into transverse segments, each containing a nucleus, by the so-called membranes of Krause; but I am clear that the myolemma adheres very closely to the fibre, and more firmly* between the closely packed nuclei of the central canal than opposite to them, so that it sometimes separates opposite the nuclei, and gives an appearance indicative of Krause's membranes. The fibre exhibits longitudinal striæ, the expression of the ultimate fibrils, which appear as bright dots in transverse sections. The dark and light alternate discs are beautifully seen, and rows of bright highly-refractive dots appear in the light discs dividing each into two.

* In this part of the fibre its demonstration is difficult. M. Viallaines considers it to be less developed and thinner at these points, and adherent to the intermediate (light) discs.

The nearest approach to the ordinary muscle fibres of the imago in the insect is the heart muscle of a vertebrate, although the characters of the two are sufficiently distinct, and the insect muscle is a more elaborately differentiated structure. The physiological character of the ordinary muscles of the imago is not completely understood, and evidence is still desirable on this subject. I believe its contractions are clonic, like those of the heart muscle, rather than tetanic, a sharp, sudden, but not a sustained contraction, and that it is differentiated from other forms of muscle, both morphologically and physiologically. My reason for regarding it as susceptible of powerful single contractions rather than tetanic contraction, is that the muscular movements of the limbs in insects are effected by sudden jerks, which are well seen when the thoracic ganglion is crushed, and the structure of the joints is such that sustained muscular exertion appears to be unnecessary. The curved mandibles of insects once driven into their prey hold by their mechanical construction, so an insect clings rather by the spinous appendages of the limbs than by sustained muscular power.

In gold-stained preparations of muscle a network of fibres has been demonstrated,* consisting of very regular transverse networks corresponding to the membranes of Krause, united by fine longitudinal fibres; and it has been recently supposed that the contraction of the muscle is due to the contraction of the longitudinal and its elongation to the contraction of the transverse fibres. If this were the case, the transverse networks being the stronger, the elongation of the muscle should be a more powerful act than its contraction. Possibly the networks are due to the coagulation of the muscle plasma, or they may be an intermuscular nervous plexus, a supposition which has some support from the structure of the electric organs of fishes, and the interfibrillar nervous network of non-striated muscle.

In conclusion, I would draw attention to a remarkable similarity between muscle fibres and capillary blood-vessels. The myolemma of the former, like the wall of the latter, consists of endothelial plates cemented together, both contain a coagulable fluid, muscle plasma, and blood plasma, and in both there are solid corpuscular bodies, muscle rods in the one, blood corpuscles in the other. The

* C. F. Marshall, "Quarterly Journal of Microscopic Science," 1887.

developmental history of the two structures is also remarkably similar. Both are developed from cells with numerous nuclei, some of which form the tubular wall, whilst others become converted into muscle rods in the muscle, and blood corpuscles in the capillary. The development of the fibrillæ of the muscle from nuclei is no longer doubtful in insects at least, and the fibrillæ may be regarded as united muscle rods.

I shall reserve for a future paper some observations on the muscle fibres of the dorsal vessel and alimentary canal in insects.

On the Disintegration of Diatomaceous Deposits.

By M. Guinard, Corresponding Member of the Belgian Microscopical Society.

Translated from the "Bulletin de la Société Belge de Microscopie."

Many means of disintegrating the fossil diatomaceous deposits are known. Amongst others, one has been lately indicated by M. J. Brun. The plan recommended by the learned Genevese Professor is based upon the recrystallization of sulphate of soda, but the operations necessary for obtaining complete success are too delicate, and exact many precautions difficult to realize practically, the most essential, to obtain saturation with sulphate of soda, being the heating of the water to about 33° C., and the consequent use of the thermometer in the vessel serving as a water bath.

I would point out a salt which I believe has not yet been suggested for this operation, and which by reason of its easy manipulation may be of use for the disintegration of diatomaceous deposits.

This method consists in introducing some fragments of the deposit into a tube, covering them to the depth of about two centimetres with crystals of common commercial acetate of soda (not pure), and finally adding thereto one or two drops of water. (For operating on a larger scale the proportion of water is five cubic centimetres to 100 of the salt.) The tube is then plunged into a water bath, and when the water is near the boiling point the salt will dissolve. The deposit absorbs the solution of acetate of soda and is left in the hot water for about ten minutes, the tube then is withdrawn from the bath, and the solution allowed to cool, or if it is desired to quicken the action, the tube may be plunged into a vessel of cold water. A minute crystal of acetate of soda is then dropped into the solution, which owing to this supersaturation will suddenly crystallize. This operation may be repeated two or three times with the same solution, and it is rarely that the deposit will not be perfectly reduced to powder.

By these means I have procured the disintegration of the most refractory deposits, such as those from the Isle of Fur, in Jutland,

but I have found six successive operations necessary to obtain a good result.

There only remains now to add water in excess to re-dissolve the crystallized salt, to empty the whole into a suitable vessel, and to add a large quantity of water.

This method has been communicated by M. Parmentier, Professor of Chemistry to our faculty of science, who has occupied himself specially with the phenomena of the supersaturation of salts.

Another substance which may be found serviceable, and which is used in the arts to detect stones cracked by frost, is hyposulphite of soda, but the manipulation is more delicate. However, I indicate the process here, but give the preference to the acetate of soda process.

Hyposulphite of soda melts in its water of crystallization ; put this salt into a capsule, heat it in a water bath to 48°, the salt will deliquesce. Plunge therein the deposit before heating, and when the solution shall be liquified and re-cooled add a small crystal of hyposulphite of soda, re-crystallization will take place, and the deposit will be disintegrated ; re-melt again and add water in excess, then decant. It will be understood that this operation must be repeated if success is not at once obtained.

PROCEEDINGS.

July 8th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Melicerta ringens	Mr. F. W. Andrew.
Orthesia ♀, sp. allied to *coccidæ*, and forming a kind of marsupium in wax ...	Mr. E. T. Browne.
Diatoms, *Porodiscus interruptus*	Mr. H. Morland.
,, *Craspedorus elegans*...	,, ,,
,, *Arachnoidiscus Ehrenbergii*, showing fine points projecting inwards from the areolations, $\frac{1}{12}$th oil imm. O.G. ...	Mr. T. F. Smith.

Attendance—Members, 16 ; Visitors, 0.

July 22nd, 1887.—Ordinary Meeting.

E. T. Newton, Esq., F.G.S., Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Richard James Cowling and Mr. George Pearce.

The following additions to the Library and Cabinet were announced :—

"Science Gossip"	From the Editor.
"The Botanical Gazette"	In exchange.
"Annual Report of the Brighton and Sussex Natural History Society"... ...	,,
"Journal of Microscopy"	,,
"The Journal of the Postal Microscopical Society"	Mr. Alfred Allen.
"The Scientific Inquirer"	,, ,,
"My Microscope"	Mr. Roper.
"Report of the Smithsonian Institution" ...	In exchange.

The thanks of the Club were voted to the donors.

Mr. T. F. Smith read "Some Additional Notes on Diatom Structure."

The Chairman said it had no doubt given great satisfaction to the members to know that they had amongst them a gentleman who, when he found he had made a mistake, was willing to come down and acknowledge it at the meeting. It was a thing which he feared very few men, even amongst those high up in the ranks of science, were desirous of doing.

Mr. Morland said as he had not yet had the opportunity of seeing the

specimen referred to by Mr. Smith, he could not give any opinion about it at that moment, but he should like to point out that he had not been quite properly quoted as to having said the "medium." What he said was the "cement," meaning what the diatoms were fixed with, and which sometimes by its contraction would produce granulations which might under some conditions be mistaken for markings. As a general rule the markings on diatoms were regular, or if not so there was some system about them which he might almost call a regularity of irregularity, compared with which the effects of the granulations of cement or other substances would be conspicuously irregul r. It was in practice very difficult to get rid of foreign matter entirely from a diatom, and frequently, after many attempts, he had given up all hopes of doing so, and on mounting the specimen he found that the irregularity had disappeared under the process when seen in the ordinary way. He thought, however, it was possible that when viewed with a different kind of illumination, under immersion objectives, the irregularity might still be perceived.

Mr. Karop said as the holiday season was coming on he should not be likely to trouble much about the finer structure of diatoms for a month or two. He thought, however, that the matter of an inner and outer membrane was one which might give rise to some misconception, because it might very often be imperfectly silicified, and therefore might by the treatment with acids be unequally acted upon so as to produce appearances which would very likely be mistaken for apertures of different kinds by different observers.

Mr. Smith said that as the objects were exhibited in the room members could easily see for themselves what had been described. He thought a great deal of the difficulty arose from the imperfect adjustment of the correction collar of the objective.

Mr. Henry Davis called attention to a fish parasite, *Gyrodactylus elegans*, which he had found upon some sticklebacks from the River Lea, and which he proceeded to describe by means of drawings on the black board.

The Chairman said that he was sure the members would be much obliged to Mr. Davis for bringing this subject before them, and he hoped some of them would be able and willing to follow it up.

Mr. J. D. Hardy said that he did not recognize this creature from the drawing and description given, but should be very glad to hear in what part of the Hackney Marshes it could be found.

Mr. Davis, in reply to this question and also to further questions from Mr. Hardy and Mr. Parsons, said that as regarded the adult forms he could see the development of the hooks taking place in the egg. He did not find the parasites himself, but his little boy got them one day during an expedition with a net and pickle bottle, and having asked to be shown the circulation in a stickleback's tail, he put one of the fish under the microscope for the purpose, and then found it to be infested with the parasites. Having a weakness for Rotifers, he wanted to make this out to be one, but was unable to do so.

Mr. Morland read a paper "On *Porodiscus interruptus* and *Craspedoporus elegans*."

The Chairman said anything from Mr. Morland on the subject of diatoms was sure to be of interest, and though he did not himself give much attention to objects of this kind he might say that it seemed a very extraordinary thing that two such utterly opposite things should belong to the same species. It showed how careful persons should be not to hastily make new species from the observation of differences in the markings alone, though it was not very often that anyone had the good fortune to find the two valves together as Mr. Morland had done.

Mr. Smith said it was quite possible for a valve to be found which had a different pattern on different sides, in illustration of which he drew a diagram upon the board of a specimen of *Aulacodiscus* as he had seen it under a $\frac{1}{12}$in. immersion objective.

Mr. Morland said this was not a question of difference of structure on different sides, but rather that of two distinct valves of the same species. There was a distinct space seen between the two, with a bubble of air between them. He could give another instance in the case of *Cocconeis*, recent specimens of which could be found *in situ*.

Mr. Karop said that the specimens exhibited the other night had all the appearance of being genuine valves belonging to one and the same frustule.

The thanks of the meeting were voted to Mr. Morland for his communication.

Announcements for the ensuing month were then made, and the proceedings terminated with the usual conversazione, and the following objects were exhibited:—

Head of "Devil's Coach Horse," *Ocypus olens*, with explanatory drawing ...	Mr. F. Enock.
Diatoms, *Coscinodiscus centralis*, from Sheerness	Mr. T. F. Smith.
,, *Coscinodiscus centralis*, from Nottingham (Maryland) deposit	,, ,,

Attendance—Members, 27; Visitors, 0.

August 12th, 1887.—Conversational Meeting.

The following objects were exhibited by Mr G. E. Mainland:—

Pupa of the Hessian fly, *Cecidomyia destructor*, and the stigma and pollen of Phlox, sp.

Attendance—Members, 15; Visitors, 0.

August 26th, 1887.—Ordinary Meeting.

J. G. Waller, Esq., F.S.A., in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced:—

"Proceedings of the Royal Society" ... ... In exchange.

"The American Monthly Microscopical Journal" ,,

"The Journal of the New York Microscopical Society"	In exchange.
"The Botanical Gazette"	,,
"The Scientific Inquirer"	,,
"The American Naturalist," two parts	,,
"Proceedings of the Belgian Microscopical Society"	,,
"Proceedings of the Geologists' Association" ...	,,
"Transactions of the Wagner Free Institute of Science, Philadelphia"...	,,
Series of Papers from the Manitoba Historical and Scientific Society	,,
"Annual Report and Proceedings of the Liverpool Science Association"	,,
"Journal of the Royal Microscopical Society"	From the Society.
"Annals of Natural History"	Purchased.

Mr. E. T. Browne read a paper on a new species of Orthezia (*Orthezia insignis*) found in Kew Gardens.

The Chairman invited discussion on the paper, and called on Mr. McIntire, whose name had been mentioned in Mr. Browne's communication.

Mr. McIntire thought he could add nothing to Mr. Browne's remarks. He congratulated the members on having secured so promising an inquirer into the secrets of the microscope.

Mr. Freeman remarked that he had brought a specimen of *Orthezia* obtained from Sphagnum Moss on a Scotch Moor, which it was interesting to compare with the new species. In the Scotch insect the waxy secretion was disposed in an even manner, like plates or scales. There was no enlargement at the end of the body to form an egg pouch. The specific name of this one was *Cataphractus,* "armed at all points."

Mr. Hardy desired to make a few remarks in further explanation of Mr. Davis' paper, read at the last meeting, on the parasite that gentleman had found on the stickleback. Mr. Davis had written to him that it was *Gyrodactylus elegans.* It was figured and described in the "Micrographic Dictionary," also in Cobbold, and in the "Linnean Transactions" of 1860. He would, however, add a few observations he had made on examining the creature more carefully to complete the description given by Mr. Davis.

Mr. Hardy shortly described what he had observed, illustrating his remarks by drawings on the black-board.

Announcements for the ensuing month having been made, the meeting concluded with the usual conversazione, at which the following objects were exhibited :—

Rotifer, *Pedalion mira*, from wet moss ...	Mr. F. W. Andrew.
Plant-Bug, *Orthezia cataphractus*	Mr. H. E. Freeman.
,, ,, *insignis* n.s. ♂ and ♀ from Kew Gardens	Mr. E. T. Browne.

Attendance—Members, 30; Visitor, 1.

September 9th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Red spider, *Tetranychus telarius*	Mr. E. T. Browne.
Puparium of the Hessian fly, *Cecidomyia destructor* (Say.) *in situ* in barley straw	Mr. F. Enock.
Radiolaria, *Orosphæria Huxleyii*, from Davis' Straits, H.M.S. Valorous, 1875	Mr. H. F. Hailes.
Diatoms, *Coscinodiscus concinnus*	Mr. H. Morland.
,, *Floscularia regalis*	Mr. C. Rousselet.
,, *Megalotrocha albo-flavicans*... ...	,, ,,
Flint with Entomostraca, &c., from the Purbeck, Swanage, Dorset	Mr. G. Smith.
Diatoms, *Arachnoidiscus ornatus*, showing a series of radial plates on inner side of disc	Mr. T. F. Smith.
,, *Eupodiscus argus*, inner side showing fine granulated membrane	,, ,,
Head of *Tænia*, from a dog	Mr. W. Watson.

Attendance—Members, 33; Visitors, 3.

September 23rd, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and unanimously elected members of the Club :—Mr. F. T. Hughes and Mr. B. T. Lowne, F.L.S., F.R.C.S.

The following additions to the Library were announced :—

"Proceedings of the Belgian Microscopical Society"...	From the Society.
"The American Monthly Microscopical Journal"	In exchange.
"The Botanical Gazette"...	,,
"Proceedings of the New York Microscopical Society"...	,,
"Hooke's Micrographia Restaurata"	From Mr. C. J. Leaf.

The President said that the last-named donation was an old work, the text of which was now for the most part obsolete, but it had still a certain amount of interest from the references made to it by other writers. The plates were also of some value, and were certainly very creditable to the time at which they were produced. It was a very desirable book for the Society to possess, and he had much pleasure in moving a vote of thanks to Mr. Leaf for his donation.

This proposal having been seconded by the Secretary was put to the meeting and carried unanimously.

Mr. Morland said there was a matter which he should like to bring before the meeting, in reference to the paper which had been contributed to the Club by Messrs. Grove and Sturt "On the Oamaru Diatom Deposit," and printed in the last number of the Journal, with five plates in illustration. He felt that a paper like that deserved some special recognition on the part of the members, and, therefore, he asked leave to move the following resolution:—"That the thanks of this Club be, and are hereby, tendered to Messrs. Grove and Sturt for the very excellent papers they have contributed to its Journal 'On the Diatomaceæ contained in the Oamaru Deposit,' of which the five plates contained in the last part have been prepared and executed at their sole cost."

Mr. Karop said he had great pleasure in seconding this resolution, and the President having formally put it to the meeting it was carried by acclamation.

There being no paper forthcoming, and the Chairman's appeal for observations from members upon any matters of interest which might have come before them during their holiday trips, meeting with no response, the excursions, &c., for the ensuing month were announced, and the proceedings terminated with the usual conversazione, the following objects being exhibited:—

Sida crystallina	Mr. F. W. Andrew.
Ophiocoma neglecta	Mr. E. T. Browne.
Flower of *Erythroxylone coca*	Mr. H. Epps.
Plumatella repens	Mr. C. K. Jaques.
Asplanchna priodonta	Mr C. Rousselet.

Attendance—Members, 38; Visitors, 4.

October 14th, 1887.—Conversational Meeting.

The following objects were exhibited:—

Melicerta janus	Mr. F. W. Andrew.
Gizzard of beetle, *Otiorynchus sulcatus* ...	Mr. E. T. Browne.
Parasite of the Hessian fly, *Semiotellus destructor*	Mr. F. Enock.
Mouths of various beetles, with labrum, &c., removed	Mr. F. Fitch.
Tomato "cuss," *Aleurodes vaporariorum* ...	Mr. J. D. Hardy.
Diatoms, *Triceratium Weissii*...	Mr. H. Morland.
A Seibert No. III. O.G. used as a simple microscope	Mr. E. M. Nelson.
Dermal plates of a fossil sponge, *Stelletites callodiscus*	Mr. B. W. Priest.
Various rotifera	Mr. C. Rousselet.
Scales from wing of *Amathusia Horsfeldii*, showing "villi" of Dr. Royston Pigott	Mr. T. F. Smith.
Crystals, Benzoyl sulphonic imide (saccharine)	Mr. H. J. Waddington.
Antheridia and globules of *Chara fragilis* ...	Mr. W. Watson.

Attendance—Members, 40; Visitors, 2.

October 28th, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Thomas Buckney and Mr. W. C. Westerton were balloted for and duly elected members of the Club.

The following additions to the library were announced :—

"The Quarterly Journal of Microscopical Science"	Purchased.
"Journal of the Royal Microscopical Society"	From the Society.
"American Monthly Microscopical Journal"	In Exchange.
"Grevillea"	Purchased.
"Proceedings of the Royal Society"	From the Society.
"Proceedings of the Hertfordshire Natural History Society"	In Exchange.
"Proceedings of the Croydon Microscopical Society"	"
"Proceedings of the Essex Natural History Society"	"
"Botanical Gazette"	"
"Proceedings of the Bristol Natural History Society"	"
"The American Naturalist"	"
"Annals of Natural History"	Purchased.
Vols. xx and xxi.—"Reports of Challenger Expedition"	"

Mr. E. M. Nelson exhibited a new portable microscope recently made from his drawings, and described the advantages it offered for field, table, and exhibition purposes. He also read a paper "On a new form of eye-piece," and illustrated the subject by diagrams.

On the motion of the President a vote of thanks was passed to Mr. Nelson for his eminently practical and useful communications.

The Secretary described a new form of portable binocular microscope, designed and exhibited by Mr. Rousselet, also a new live box and compressorium, by the use of which an object could be examined in any part of the field.

The thanks of the Club were returned for these communications.

Mr. T. F. Smith read a paper "On the finer structure of Butterfly and Moth Scales," which he illustrated by diagrams and specimens exhibited under several microscopes.

Mr. E. M. Nelson said he felt much indebted to Mr. Smith for bringing down these scales for exhibition; they were beautifully shown and were well worth attention. In the scale of the moth the resemblance to the stellate hairs of plants was very noticeable. The beading on the scale of

Menelaus he had seen before. The other he had gone over carefully with an oil immersion, but did not get more than Mr. Warren de la Rue had obtained; but on focussing lower down he fancied there was evidence that the objective gave the image of the lower side as well as of the upper side.

Mr. Stokes said, with regard to the statement of "pigment being figment," he might say that a friend of his had been getting the colour out of some of the scales, and he found that the colours obtained differed in various kinds of butterflies and moths.

Mr. Smith said he had never seen any trace of pigment cells himself, but there were in some instances some little tubes found which possibly might contain something of the sort. The coarser scales were simply composed of one membrane.

The President said it would, of course, be unfair to in any way criticise or judge of the matter before them without having first examined the objects to which Mr. Smith had called attention; but, so far as his own observations went, he thought there could be little doubt that in most cases scales were double, and it frequently happened in such cases that one surface gave one image and the other one gave another, the ordinary appearance being the result of a combination of the two. In most cases this was an interference image, just the same as might be produced by placing two surfaces of muslin, or other perforated material, one over the other. A great variety of patterns might be produced in this way, and it had always struck him that many of the patterns on scales were due to this kind of interference. He had also noticed how common it was, that when a person came to examine with high powers, surfaces which had previously been supposed to be smooth, he discovered that they were not so.

The thanks of the Club were unanimously voted to Mr. Smith for his paper.

The President said that, according to the agenda, a paper by Mr. Lowne was to have been taken next. As, however, their time had so far expired they proposed, with Mr. Lowne's concurrence, to postpone the reading of this paper to their next meeting.

Mr. Morland read a reply to a criticism in the Royal Microscopical Society's Journal for the current month, on his paper on "Mounting Media, so far as they relate to Diatoms."

The Secretary announced that he had received applications for assistance of members at the Soirées of the Croydon, and South London Microscopical Societies, both of which, however, were arranged to take place on the same evening. Meetings of the Club for the ensuing month were also mentioned, and the proceedings terminated with the usual conversazione, and the following objects were exhibited:—

Pelomyxa palustris	Mr. F. W. Andrew,
Campodea staphylinus	Mr. E. T. Browne.
Hydra vulgaris	Mr. H. A. Crowhurst.
Parasitic fly, *Callimome regius* ♀	Mr. F. Enock.
Section of eye of butterfly, *Pieris brassica* ...	Mr. H. E. Freeman.

Asplanchna Brightwellii, with ephippial or winter egg	Mr. C. Rousselet.
Pork measle, *Cysticercus cellulosa*	Mr. W. Smart.
Scale from wing of butterfly, *Amathusia Horsfeldii*, showing the "villi" of Dr. Royston Pigott	Mr. T. F. Smith.
Scale from wing of butterfly, *Papilio memnon*, showing same...	" "
Scale from wing of butterfly, *Morpho menelaus*, showing same	" "
Scale from wing of moth, *Zygæna trigonilla*, showing same...	" "

Attendance—Members, 49; Visitors, 5.

On the Structure of Butterfly and Moth Scales.

By T. F. Smith.

(*Read November 25th,* 1887.)

At the last ordinary meeting of this Club I read a paper on the structure of butterfly and moth scales, and exhibited some specimens showing the villi discovered by Dr. Royston-Pigott. There was no doubt in my own mind about the villi, nor, I think, in the minds of any of those who saw them; but the specimens had been far too short a time in my possession to allow me to speak positively of their position, although I expressed an opinion that, in one instance at least, they were between the two membranes of the scale.

Since then, however, I have been able to examine torn specimens, and have now no hesitation in asserting that this is the structure in all cases. If you come to think about it you will see that it is almost impossible it should be otherwise, seeing that these little filaments are often not more than the 100,000th of an inch in diameter, and could not stand the wear and tear during the insect's life, unless protected in some such manner.

Of course, if there were positive evidence that the villi were outside the membranes there would be an end of all speculation at once, but to me all the evidence so far points one way, and that in an opposite direction. In no single instance have I seen them project beyond the outline of the scale even when twisted on itself, and it would be impossible but what some would project so if outside. But what I chiefly rely upon is the evidence of torn scales, such as the specimen I have brought here to-night for your inspection, and which will, I think, convince you that the villi are inside and not out.

The scale under the microscope is from *Urania rhypheus*, and it happens to be a scale of Urania in which the villi were figured, as pseudo-beading, by Mr. McIntire, about a dozen years ago in the "Monthly Microscopical Journal." The villi on this scale differ from many in not being so numerous, but appear in well-defined

rows some distance apart. In the specimen shown to-night the under corrugated membrane, with the cross-bars, has been torn away from a considerable part of the scale, but has left the upper smooth membrane intact. Now this upper smooth membrane, from its thinness, is optically non-existent when mounted in balsam, unless you can focus on the broken edge; but its presence is apparent here from some of the villi remaining attached to the under side. Had the whole of the villi remained intact it would have pointed to the probability of their being outside ; but as the most of them are gone they were evidently torn away with the under membrane. There seem to me, then, to be two points settled. First, that all butterfly and moth scales have certain projections or villi, springing from their surfaces; and that, secondly, these projections are contained between the two membranes of the scale. They assume various forms, consisting in some cases of little tufts branching from one root or point; in others of little rods tapering at one end, which run straight from one membrane to the other ; in others they have a distinct stem with a rounded head ; and in others are simply bosses standing on the ribbings and cross-bars.

I assume their purpose is to separate one membrane from the other, and the villi are more or less pronounced in character according to the distance the membranes are separated. They differ, even in the same scale, and are always largest in the quill, which they keep expanded by interlacing in all directions. Various also, is the manner in which they are distributed in the scales of different species, and I don't think diatoms themselves can show more distinct forms.

Dr. Pigott, in his papers on this subject, has spoken many times of isolated beading in the scales, and his last paper to-day almost deals exclusively with this point. My own opinion, however, after a careful examination of many scales, is that there is no isolated beading, but that in all cases they spring from the ribs or the cross-bars.

On the Formation of Diatom Structure.

By E. M. Nelson.

(*Read January 27th*, 1888.)

Plate XVIII.

I have some misgivings in bringing this matter a second time to your notice, neither would I do so had I not lately found some fresh examples which throw additional light on the subject. Further, I believe we are on the verge of a new departure in the field of microscopical work, viz., illustration by means of lantern pictures from photo-micrographic positives. I have brought a lantern with me to-night, and have chosen this as my first subject, illustrated by photo-micrographic positives of my own manufacture.

My first picture is that of a portion of *Coscinodiscus Janischii* (Plate XVIII., Fig. 1), a drawing of this I have already exhibited here. It shows an increase of structure from the centre to the margin, an areolation is at first indented by the formation of a process, in the next areolation, counting towards the periphery the process is longer, in the next it has nearly reached the opposite side of the areolation, in the next row you will observe that the single areolation has become two ; these increase in size and divide again. This to my mind indicates a growth from the centre outwards.

Now we come to a series of six photographs of fragments in the Brünn deposit.

The first, Fig. 2, you will probably recognize as the one with the fiddle *f* mark described in the paper " On the Finer Structure of Certain Diatoms," by Mr. Karop and myself.* Before passing on let me ask you to notice the accuracy of Mr. Karop's drawing, the identical areolation being easily recognizable.

In Fig. 3 the areolation becomes more circular, the central cut in the *f* has joined the openings at the ends which causes it to

* " Journ. Q. M. C.," Ser. ii., Vol. iii., No. 18, Pl. IV., Fig. 7.

assume the appearance of a somewhat oval areolation with two tree-like processes in it.

In Fig. 4 the tree-like expansions at the end of the processes are much diminished, and in some the boughs are altogether wanting, the processes then taking the form of a pollard willow.

In Fig. 5 there is no expansion at all on the top of the process. The process is a mere spike projecting into the oval areolation.

In Fig 6 the process or spike has disappeared, leaving only a small indentation at the margin of the areolation.

In Fig. 7 you have a clean oval and regular areolation which resembles that on *Isthmia nervosa*, but without secondary structure.

Hitherto I have been either unable to find, or unable to resolve, secondary structure in this diatom. It should, however, be very carefully watched, as it is undoubtedly an interesting point, whether the areolation is first formed and the secondary structure is a subsequent growth or not.

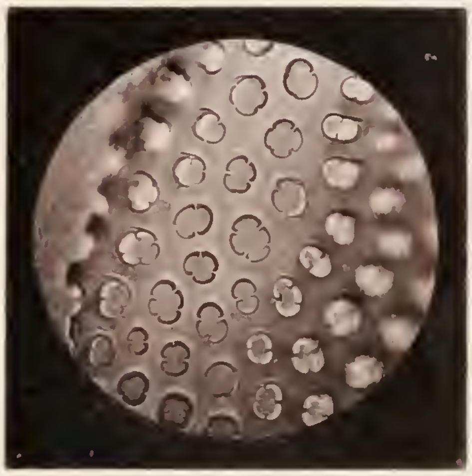
In the first instance we have an illustration of the increase of silex and of the diatom generally, and in the other six the growth, so to speak, of the areolations.

It may be said that Fig. 7 shows the elementary structure, and Fig. 2 the most highly developed. I have no evidence to bring that that is not the case, but I can only give it as my own opinion that the reverse is what has really taken place.

1

2

3



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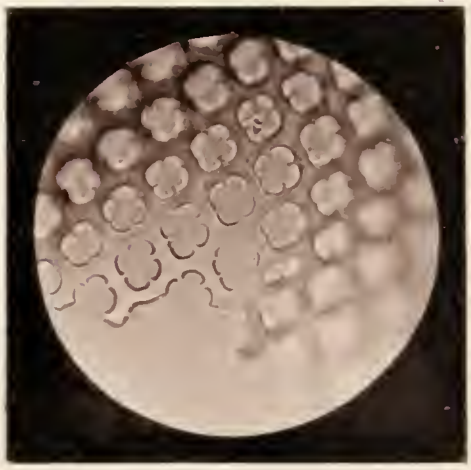

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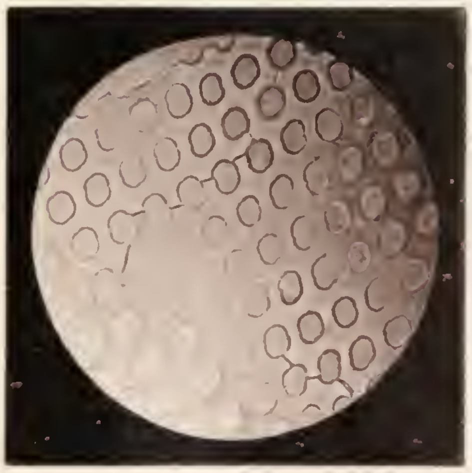

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7

On some New Appearances in Podura Scale.

By T. F. Smith.

(Taken as read, January 27th, 1888.)

I beg to call the attention of the members of the Club, to a new appearance of the Podura which I do not think has yet been recorded. On searching over a slide of this scale the other day with an oil immersion, to see if I could not produce Dr. Pigott's beading, I was struck with one that displayed entirely new features. You all know the optician's appearance of this scale, with the exclamation marks, blue or red, according to the corrections of the glass, and with a light streak in the middle, more or less extended as the aperture is larger or smaller. But in the specimen before me the usual markings had vanished, and in their stead the whole scale was studded with very slender spines with round heads, and the pointed ends stuck into the scale like a lot of pins stuck loosely and anyhow into a paper, and instead of being blue or red were a pure white. At first I thought there were two sides to the scale, and this was the wrong one, but I soon discovered that this scale was tight against the cover, and that all the scales so placed had the same appearance.

Since then I have examined many scales on several slides, and am now strongly of opinion that the notes of exclamation markings are spurious, and that the light streak is the true appearance, which has hitherto been seen with the darker outline on each from taking too deep a focus.

It is a well-known fact that an oil immersion objective works only with its full aperture, when an object mounted dry is well on the cover, and this in itself should be sufficient evidence that the appearance the object presents, under these circumstances, is the truer one. Then, again, the pin-like looking spines are not more than half the diameter of the exclamation marks, and the image is always at its smallest when in focus; never larger. Another fact which guides me in my estimation of the structure is the observation of a hair with small projecting spines. Here was structure of

which there could be no doubt, and the same point of the correction collar that gave the sharpest image of this hair gave also the sharpest image of the spines on the scale. Still another proof. To bring the notes of exclamation marks out well requires a deal of management of the light, and are best seen with the smallest apertures of the condenser; but no amount of light will obliterate the new ones or prevent them from standing out sharply from the general blaze. I may say that the two smallest apertures of my condenser always give false images, and in general work I never use them.

I have brought two specimens of the scale for your inspection to-night, and have placed one under a $\frac{1}{12}''$ oil immersion and the other under a new dry $\frac{1}{8}''$. The scale under the $\frac{1}{12}''$ is doubled up near the quill, and the pointed ends of two or three of the spines have forced their way through the membrane and project by themselves some considerable distance. On the companion scale under the dry $\frac{1}{8}''$ you may develop some very respectable beads by using the smallest aperture of the condenser, but they instantly vanish when the light is restored. I have tried the same experiment on the same scale with the oil immersion, but it has too much aperture even then to lend itself to the falsehood.

Since writing this paper I have spoken to Mr. Pringle—a no mean authority on micro-photography—and he tells me that some time ago he photographed this scale as presenting the same appearance I have been trying to describe to-night, and got severely sat upon in consequence. What I have been calling pins he calls French nails, but the difference is not great.

Notes on Villi on the Scales of Butterflies and Moths.

By Dr. Royston-Pigott, M.A., F.R.S.

(*Read January 27th,* 1888.)

(Abstract.)

The resolution of these difficult objects is a capital introduction to the study of the minute structure of disease germs, and I can strongly commend it to the attention of microscopists who have neglected this department of natural history. Dr. Gabbett, of Eastbourne, has made a large collection of germ slides, and has succeeded in cultivating some very interesting micrococci closely agglomerated in single layers. Each point appears perfectly circular, and is finely edged with a minute jet black ring. The thickness of this minute black test ring may be estimated at $\frac{1}{250000}$ of an inch. But when the micrococci occur in several layers they can scarcely be resolved, and no test rings are visible. This fact demonstrates the extreme difficulty of resolving the minute beading existing in subjacent layers, as, for example, in the test Poduras.

Many of the villi in butterfly and moth scales are pawn-shaped, possessing a base and a spherical summit. This form was the first one discovered, with exceeding difficulty, on the scales of the Red Admiral Butterfly.

The scales of *Amathusia Horsfeldii* gave clearer indications, but their extreme delicacy permits of no pressure being applied, as it flattens and distorts them. After seven years' prosecution of the research, I was rewarded with finding an entirely new vein, which has proved very rich in material, in moths of the *Zygœna* tribe.* It is rather difficult to arrange all their complicated forms methodically, and I shall therefore first sketch generally some of their remarkable appearances.

* There are about 100 species of this genus scattered over many countries. Mr. Hinton, Vorley Road, Holloway, has prepared a number of slides, at my recommendation, showing many forms of beading, ribbing, and villi. Mr Watkins, of Painswick, has also supplied me with 40 species of *Zygœna*.

Occasionally they are seen to lie flat upon the basic membrane, and to be connected by cross ramifications, interlacing in an extraordinary manner. At other times the bases of the villi are ciliated, forming reticulations, resembling ancient hieroglyphics or archaic writing. Their thickness varies from $\frac{1}{60000}$ to $\frac{1}{120000}$ of an inch, and their length is sometimes prodigious.

The villi principally observed at present take the following forms :—

I. *Beaded Villi.*
II. *Embossed Villi.*
III. *Pillar Villi.*
IV. *Ciliated Villi.*
V. *Connected Villi.*
VI. *Banana* or *Bunched Villi.*
VII. *Spinous Villi.*
VIII. *Tall Villi.*

Out of about 400 preparations (dry mounts) of scales obtained from all parts of the world, I propose to select a few which with good object glasses give some startling results. I should here premise that when the heads of the villi make contact with the cover glass they always produce black circular discs more or less minute.

I. *Beaded Villi. Papilio erectheus;* male; Australia. Hind wing of butterfly. Powell's 1-12th oil N.A. 1·43. Innumerable black contact heads of villi on dark red scales, which generally show brilliant test beads, glittering with extraordinary beauty and precision of form. Between open ribs are scattered irregularly remarkable isolated beads, varying much in size. With very fine object glasses these beads exhibit jet black or blue black circular margins and bright focal discs.

II. *Embossed Villi. Zygæna lonicera.* Some of the dark scales of this moth display amazingly large embossed villi of irregular shape. The long scales are the most beautifully marked, and the villi are in places much prolonged. The scarlet and steel grey scales show unusual thickness, and when the ribs lie upwards the spots or villi appear a long way below them, attached to the other or unribbed membrane. But even the little short grey scales reveal very long filamentous villi developing into villi broad and and black. *Zygæna lavendulæ* exhibits also most extraordinary irregular villi on dark scales.

III. For *Pillar Villi* examine scales of *Papilio philenor.* The

pillars appear to support the membranes of the closed sac, and often bright beads are seen accompanying the villi. The effects below it are very striking in different focal planes.

IV. *Ciliated Villi.* Delicate hairlets spring from the base of the villi, assuming fantastic forms, spiral, anastomosed, contorted, twisted, spreading, rising and falling in different focal planes, which (when compressed by a touch of the object glass) adhere *flatly* to the unribbed membrane.

V. *Connected Villi.* Impossible to describe in writing without elaborate plates.

VI. *Banana* or *Bunched Villi.* Several villi appear to start from one root, and branch up like a bunch of bananas, *i.e.*, before they have been squeezed down. These branches define beautifully with two black margins ; yet I judge them to be solid, transparent filaments. Some of the *Zygæna* scales exhibit very strange-looking bunches attached to one root, apparently piercing both the upper and lower membranes, thus securing firm pillar attachments.

VII. *Spinous Villi. Zygæna minos.* Abrupt short cross-bars, being villi flattened down. There are two sets, one for each membrane. The very delicate pale scales show up the best.

VIII. *Tall Villi. Zygæna ephialtes.* Most curious hair-like appendages on under side of scales. Large bases to villi. Double ribbing occasionally, which twist together the lower ribs into odd shapes. Cylindrical fibres embodying most grotesque forms all along the median line. Rather tall mushroom-like villi.

Parasitism.

Address of the President, A. D. Michael, F.L.S., F.R.M.S.

(*Delivered Feb. 24th*, 1888.)

Among the descriptions which explain the nature of the objects shown at this, and most other, microscopical societies, there probably is not any more frequently found than "parasite of some creature," as, for instance, of the horse or the fowl. This is natural enough, for parasites are usually, and almost necessarily, of small size as compared with their hosts, and fall within the range of those studies which cannot be pursued without the aid of a microscope; moreover, the worker with that instrument, while he shares the horror of parasites which is common to most civilized human beings, still feels irresistibly attracted by their curious and exceptional life-histories, and has a strong tendency to collect and exhibit them. Possibly familiarity breeds indifference. I well remember that when our late lamented President, Dr. Cobbold, exhibited living larvæ of that terrible entozoic worm, "the *Bilharzia*," at the Linnean Society, he could not understand why men were not particularly anxious to approach his microscope and bottles. In the lists issued by the dealers in microscopical objects will be found long series of parasites and their eggs; yet probably not one in fifty of those who exhibit and deal in these things ever really considered what he meant by a parasite, and the greater number would be somewhat astonished if they were informed that, according to the views expressed by eminent authorities, most of the creatures which they exhibit are not parasites at all; while many animals are entitled to that appellation which are not included in our exhibitors' lists. It may, therefore, be worth spending half-an-hour in endeavouring to obtain rather clearer views as to what a parasite is, and in reviving our recollection of a few of the more interesting forms of parasitic life. We have to ask, 1stly, can we define the popular idea of a parasite? 2ndly, does it agree with the scientific idea, or rather with any of the scientific ideas? 3rdly, if it do not, which, if either is correct? It is strange to see how men's views have varied

in this matter, and from what opposite standpoints authors have attempted to classify parasitic forms of life.

A parasite is defined in Jameson's edition of Johnson's dictionary as being " one that frequents rich tables and earns his welcome by flattery." This probably corresponds with the derivation of the word from παρα, beside, and σῖτος, food, but it does not appear altogether applicable to a *Tænia* or an Ichneumon. Jenkens' lexicon comes somewhat closer to our notions; it states a parasite to be " a hanger-on; a plant or animal living on another." These probably are not works in which we should expect to find any great scientific exactness; let us therefore see what have been the opinions held by those who have endeavoured to regard the matter from a strictly scientific basis. General works on parasites are not numerous, yet there are some to be found, although they are chiefly confined to the parasites of man. Saint-Fargeau, one of the earlier writers, says, " The parasite is he who lives at the expense of another, eating his host's property but not his host." This has a certain quaint resemblance to Johnson's idea, but if such was ever the received view it has been somewhat widely departed from.

" Parasites," says Küchenmeister, " are independent organized beings, descended from peculiar animal or vegetable parents, which require, in order that they may be enabled to complete their development, growth, or reproduction, to take up their abode, either constantly or temporarily, in or upon a second animal or vegetable organism of a different kind from which they derive their nourishment." This definition is getting very close to the ordinary idea, but it scarcely seems quite consonant with the fact that Küchenmeister appears to treat bed-bugs, fleas, blow-flies, gnats, and mosquitoes, as parasites of man.

Van Beneden, in his well-known work, which is still probably the best on parasites generally, does not put his definition in any single sentence, but his opinions are evidently exactly opposite to those of Saint-Fargeau; he says, " Those creatures which merit the name of parasites feed at the expense of a neighbour, either establishing themselves voluntarily in his organs or quitting him after each meal like a leech or a flea." It is evident that Van Beneden does not consider a creature to be parasitic unless it *does* eat its host; but he considers that it must not kill him, at all events not at one meal; those which do not eat the host he calls " messmates," or " mutualists;" thus, according to him, a leech, a flea,

a gad- or Tsetse-fly, a vampire bat, and every other animal which ever consumes any living portion of another living animal without killing it, is a parasite, while the *Ricini*, the feather-eating *Mallophaga*, and the *Dermaleichi*, which form the bulk of the microscopical preparations of parasites, are not parasites at all, because they do not eat the host, but only keep its hair, skin, or feathers clean.

Mr. P. Geddes, in the "Encyclopædia Britannica," scarcely defines animal parasites, although he classifies them, but he includes the *Mallophaga.*

Mégnin, one of the latest writers on animal parasites, says, "Parasites are beings which live at the expense of other living beings." He includes the gnats and that class of creatures, but he also includes the *Ricini.*

The popular idea is probably intimately connected with the question of position; a creature which lives upon or in another living creature is regarded as a parasite whether it eats its host or not, and a perfectly free-living animal, which only attacks some other being when it is in want of a meal, is not looked upon as parasitic. I cannot help thinking that some definition founded more or less upon the popular idea is, after all, the best. Let us take the gnats and mosquitoes as excellent examples; they undoubtedly do attack us and suck our blood when they have a chance, but as a rule they are vegetable feeders, and probably of the enormous numbers of these annoying *Diptera* which are born only a very small proportion ever taste blood at all; they are not most abundant where animals are numerous, quite the contrary. The midge swarms to such an extent in many of the wildest glens of the Scottish Highlands that it is hardly possible to stay in the places on a summer evening, unless provided with midge-masks. The mosquito is generally supposed to be a specially southern creature, but this is incorrect; there is probably no place on the face of the earth where it is found in such countless myriads as in the Tromsdal, a romantic uninhabited valley in Norway, considerably north of the Arctic circle. This valley is almost without vertebrate life, and is only visited by the Lapps, for a few hours at a time, when they drive their tame reindeer down from the mountains for the inspection of such visitors by the steamers as are prepared to pay for the sight, and have telegraphed to the agent in Tromso to bespeak it; but in the bright and busy little town of Tromso itself, which is only divided from the Troms-

dal by a narrow arm of the sea, a mile or so wide, I was assured by the natives that the mosquito is comparatively scarce. What a very small proportion of the Tromsdal mosquitoes can ever have sucked blood, and yet it is suggested that they are parasites. Again, take a leech, although here the question is more difficult. It is admitted on all hands that a lion is not a parasite, it kills its prey and eats it; but it is said that a leech *is*, because it does not kill its prey; but if it happen to attack a very small creature it probably does kill it, and surely the question of whether it is a parasite cannot depend on the size of the particular creature attacked. On the other hand, it seems very odd to be told that the *Mallophaga* and *Dermaleichi*, which live all their lives, in every stage, upon particular birds, and will not live elsewhere, are not parasitic. Of course it clearly is not necessary in order to constitute parasitism that the residence of the parasite upon the host should be permanent; it may be temporary only; but it does seem to me that it must be more than seizing the so-called host in order to make a single meal. Confining ourselves for the moment to animal parasites upon animals, may we not say that a parasite is a creature which, at the time spoken of, is residing in a permanent or temporary manner in or upon another living creature, and is existing at the expense of or by the assistance of the host. Of course no general definition is likely to be exhaustive, or quite to meet every case; for instance, the well-known British parasitic anemones, *Sagartia parasitica* and *Adamsia paliata*, are found, the former on the back and the latter round the mouth of univalve shells which have lost their molluscous tenants and have been taken possession of by soldier-crabs; it may be said that the anemone does not live upon the crab, but only on the roof of his house. There is, however, a singular instance of one of the foreign crabs which usually has an anemone adhering to each large claw, and goes about waving them in a manner which doubtless renders the *Actinia's* fishing operations very easy.

Another difficulty, however, occurs far more serious than such small points as that last named; there are vegetable parasites as well as animal. Milne Murray, in the "Encyclopædia Britannica," says "the name of parasites has been given to those plants which are nourished wholly or partially at the expense of other living organisms," and this seems fairly to express what is the ordinary idea, both scientific and popular. Not only are such plants as the

Mistletoe, the *Orobanche*, and the Dodder regarded as parasitic, but the fungi of favus and ringworm, the muscadine of the silkworm, the pathogenic bacteria, &c., are looked upon in the same light; although they are parasitic, not upon other vegetables, but upon animals; and it certainly would appear strange if such forms as *Saprolegia* were not considered parasitic when attacking the *Salmonidæ*, but other allied species when attacking vegetables in a similar manner were parasitic. On the other hand, Van Beneden has very properly said that if vegetables feeding upon living animals are parasitic, then it is unscientific not to consider animals which feed upon living vegetables as also parasitic; and he consequently suggests that there are more animals which are parasitic than which are not so. It may be well worth considering whether it would not be better to confine the term parasites to organisms which are parasitic upon other organisms belonging to the same natural kingdom; if this be not done, and if we admit with the various writers that in order to be a parasite it is not necessary to reside upon or in the host, that it is not necessary to feed entirely or usually on the host, or always on the same host; or that all individuals of the parasitic species should ever seek assistance from the host at all, occasional repasts by scattered individuals being sufficient, then we should arrive at the somewhat startling conclusion that most animals are parasitic, and that the non-parasitic are rare exceptions almost confined to predatory creatures. The caterpillar would be parasitic upon its food-plant; the bee and the butterfly upon the flowers they suck; the cow and the sheep upon the grass they eat; and we cannot be sure that even man himself might not be held to be parasitic upon such organisms as fruit-trees and Brussels-sprouts.

Now let us glance shortly at how parasites have been classified. Van Beneden first separates messmates, which he divides into fixed and free; then he separates mutualists, which he does not divide; finally he comes to parasites, which he divides into those which are free during their whole lives, those that are free while young, those that are free when old, and those which are not ever free. Leuckart distinguishes first between ecto- and endo-parasites; the former he divides into two sections, viz., temporary and permanent; the latter into three sections, viz.: (1) those having wholly free-living embryos; (2) those having embryos passing through a different host; and (3) those without any free-living period passing their

whole existence in one host. Kossmann attempted what may be called a physiological classification, viz. : (1) *Diosmotici*, or vegetative, without independent digestive organs ; (2) *Digestorii*, with independent digestive organs, and these latter are divided into *Sedentarii* and *Vagantes*. Mr. Geddes classifies according to the nature and degree of the parasitism into commensualists ; parasites within the same species, and hyperparasites. Mégnin divides parasites into two great classes, viz., harmless and hurtful ; and, indeed, no better summary of the different views can be given than the well-known quotation from Terence, *Quot homines tot sententiæ.*

I will now refer to a few of the varied and curious forms which parasitism assumes.

Amongst the order of beings to which I have paid the most special attention, namely the *Acarina*, there are numerous examples of almost every kind. Unquestionably the best known is the itch-mite (*Sarcoptes Scabiei*), which has brought itself very unpleasantly under the notice of the human race. It is a true parasite, living its whole life in or upon one individual, and feeding upon the substance of its host. The literature relative to this tiny creature is so voluminous that Fürstenberg's summary of it occupies 172 closely-printed folio pages of his book, and has rightly been called a marvel of human labour ; and yet Fürstenberg wrote in 1861 and the literature has been rapidly increasing ever since. It is curious that in his magnificent work Fürstenberg carefully draws every species of itch-mite as having two pairs of chelate mandibles, a thing not only incorrect in itself, but also entirely unknown in the whole order of *Acarina*. I do not propose to add to the mass of printed matter on this not very attractive subject, and will simply remind you that it is an error to suppose that cleanliness is an entire protection against this unwelcome visitor. It doubtless assists considerably ; but although the adult, egg-bearing female lives in burrows in the skin and is probably rarely transferred, yet the immature forms and the young adults live on the surface, and being minute, hyaline creatures, not visible to the naked eye, may be passed from individual to individual by the morning newspaper, the handle of a door, the clothes from the wash, or in a thousand other fashions. Luckily, now that the disease is understood, a cure can be effected with absolute certainty; but amongst animals, which cannot rub each other with sulphur and the like, the result is different, and the largest and fiercest carnivora are sometimes

killed by a *Sarcoptes*, not from injury to any important organ; they simply die worn out by want of rest. In the French Army, after the Franco-German War, the disease spread so suddenly amongst the cavalry horses as to become very serious, and in this case, and that of some other animals, as the camel, it was found that the disease could be more or less communicated to the human attendants, although it did not proceed far with them, soon dying out without remedies.

A marked contrast to the *Sarcoptes* is offered by the only other Acarine true parasite of man, the *Demodex folliculorum*. This curious little being, with its short legs and its long tail, is a permanent parasite, but a harmless one. It lives calmly from generation to generation inside the sebaceous follicles of our noses and in our ears without our usually having the least idea of its presence. It appears, however, to be otherwise in the pig and one or two other animals, in whose skin a *Demodex* breeds in such quantities as to produce a diseased state.

A curious and very doubtful temporary parasite of man is the so-called harvest-bug. If we go for a walk in late summer amongst long, very dry grass we shall probably come home with an itching on the calves of our legs, which will soon become intolerable. An ordinary examination will possibly not disclose anything except the result of our own scratching; but careful study with a good lens will reveal a number of small white pimples with a minute scarlet demon seated on the top of each. This demon is the young hexapod larva of some species of *Trombidium*, for he may belong to any one of several species. A drop of turpentine will probably dislodge him; if left alone he will die a natural death in two or three days. He is the *Leptus autumnalis* of the earlier writers, who supposed the six-legged mites to be separate genera, not knowing that they were simply the larvæ of the eight-legged mites. Why these predatory creatures should leave their happy hunting-grounds among the grass to fasten on to my leg I never could quite understand; it does not agree with them, for they die there. If they were older they would have learnt wisdom, for the nymphs and adults of the same species are not ever found adhering to the skin. The irritation produced must probably result from some poison, not from any wound so minute a creature can inflict; and looking at their close relationship to spiders, and their similar mode of life, this seems probable.

The ordinary *Ixodes rinaceus,* called the dog-tic, seems to me to bear somewhat the same relation to the harvest-bug that *Demodex* does to *Sarcoptes.* If entitled to be called a parasite at all it is a very temporary one. It lives in the ferns and bushes apparently on vegetable food, but will undoubtedly attach itself to any passing animal. Many authors consider that this creature produces irritation, so I suppose it must with some. Personally, I have often found it on my arms after a day in the woods, but have not ever found it out except by sight. It drives its rostrum, with the two rows of great recurved hooks, right into the skin, and it is surprising that the wound should not be more felt. Authors say that if a drop of turpentine be placed on the *Ixodes* it will withdraw its rostrum, and I suppose it must be so ; but those that have favoured me with their attentions have not been kind enough to do this, and I some time since received from Miss Ormerod a piece of ox-hide which had come from South Africa in spirit. It had three very large *Ixodidæ,* close together, so firmly fixed in it that I had to cut deeply into the hide with a dissecting-knife in order so release the rostra. The bite of all the British *Ixodidæ* is not painless, if I may trust the assurance of a well-known entomologist, who told me that on one occasion when he put his hand into a swallow's nest to search for beetles the *Ixodes* inside bit like a dog. The severity of the bite of the allied *Argasidæ* is well known.

You will find numerous other *Acari* treated as parasites of man by various writers ; as to most of which it need only be said that many *Acari* which are not parasitic are very small and very quick, and very apt to get into unexpected places.

One of the most curious forms of limited parasitism found amongst *Acarina* is that of the *Hypopus.* In the collection of this Society will be found a slide of a large flea with numerous *Hypopi,* which were supposed to be inside it. A careful examination will show that this is an error, and that the *Hypopi* are only between two segments of the abdomen, being in the part where the anterior edge of a segment is drawn within the posterior edge of the previous segment in a telescopic manner, thus providing a place of shelter for the *Acarus.* The *Hypopus* is usually a minute creature, flat on thev entral surface, but entirely covered by a smooth, arched, dorsal, chitinous carapace ; its hind legs end in hairs like those of the itch-mites, and its mouth is rudimentary, consisting only of a short, closed, membranous tube ending in two bristles. It is

curious to see what different views acarologists have held as to the nature of these animals. All the earlier writers considered them to be distinct organisms, and gave them generic and specific names. Dujardin first suspected that they were only forms of some other known creatures; he found them abundant with and on *Gamasidæ*, and expressed his conviction that *Hypopus* was a young *Gamasus*. Gerlach was probably deceived by the hind legs and the parasitism, and declared them to be adult itch-mites. Gervais, without giving any reason, classes them as adults of the genus *Tyroglyphus;* this is somewhat strange, because they do not look in the least like *Tyroglyphus*. Gervais does not profess to have made any discovery, and yet it is the first instance in which the connection, which really exists, between *Tyroglyphus* and *Hypopus*, is referred to. Claparède followed this idea up. He was not a man to put forward anything without reasons; he had previously been studying *Hoplophora*, one of the *Oribatidæ*. In this creature the nymph is soft and white, the adult hard and chitinous. Claparède now took to rearing one species of *Tyroglyphus*. He got plenty of larvæ and nymphs, plenty of adult females, but no adult males; but he did get a number of hard, chitinous *Hypopi*, and he satisfied himself that each of these emerged from a soft white *Tyroglyphus*-nymph, leaving only a cast skin behind it. What could be more convincing? Claparède announced his discovery that *Hypopus* was the male of *Tyroglyphus*. Unfortunately this was disproved even before it was published. Robin and Fumose happened to be studying the same *Tyroglyphus* at the same time; the Swiss and the French naturalists were working in entire ignorance of one another's labours. Robin and Fumose published their results a few days first; they had found and bred the male in abundance, but it had not struck them that the *Hypopus* belonged to the same life-history. Next came Mégnin, who, as the result of experiments in which he alternately allowed his breeding boxes to get dry and then supplied fresh pieces of fungus, came to the conclusion that *Tyroglyphus*-nymphs had the power of changing into *Hypopi* when drought or other circumstances were unfavourable to their existence as *Tyroglyphi*, and of changing back again when circumstances were once more propitious. Afterwards Andrew Murray brought forward the somewhat startling theory that *Hypopus* was a ferocious internal parasite, which entirely eat up its host, the

Tyroglyphus-nymph, leaving nothing but the skin. Finally, Haller came nearest to the truth when he said "Hypopial form is a travelling-dress." Some years ago, during a short stay in a country house, I was struck by the fact that almost every fly, or other small moving creature, which came out of the cucumber-bed was laden with *Hypopi* to such an extent that I called the flies "the emigrant ships," and yet *Tyroglyphus* was swarming and evidently thriving in the hot-bed. I easily satisfied myself that the *Hypopus* really was an immature stage of the *Tyroglyphus*, but the circumstances did not seem to admit of Mégnin's explanation. I was thus led to undertake a series of experiments, too long to be detailed here, by which I think I proved that *Hypopus* is a stage occupying the period between two ecdyses of the *Tyroglyphus*-nymph, and which, although it does not occur in all individuals, is a perfectly normal condition, not induced by any adverse circumstances, but forming a provision of nature for the distribution of the species far more efficient than any adopted by the *Tyroglyphus* form, which would die if carried by the fly into hot sunshine or warm dry places. Here, then, we have an instance of a parasite, if that name can really be applied to it, which resides temporarily upon the host, but requires nothing from him except conveyance to "fresh fields and pastures new;" the host is really the emigrant ship, as I used to call it. Another curious acarine parasite, whose parasitism is of a somewhat allied nature, is *Uropoda vegetans*. This creature looks rather like a large *Hypopus* at first sight, but even a cursory examination will show that it is a very different being. Its mouth organs, instead of being rudimentary, are more highly developed and complex than those of any of the *Acarina*, except its brother *Gamasids*. It possesses tracheæ which are absent from *Hypopus*, but like that creature it only uses its host to convey it to suitable food. It is predatory, living upon very minute insects and *Acari*. The small quantity of fecal matter, which passes from the minute round anus of this or other closely-allied species, soon hardens on exposure to the air, and by this it is attached to the host; the attaching matter, of course, increases in quantity, but it does so by adding to the length, not the thickness, of the stalk. Thus the *Uropoda* is at last attached to the host by a long thin stalk, which keeps host and parasite some distance apart. The host is most commonly a beetle, and the *Uropoda*, when attached to one of the beetle's legs, has an ex-

cellent opportunity of using its long agile mandibles for capturing its prey when the beetle is grubbing in the earth or dirt where they abound. Slightly similar instances occur in other orders of beings, thus the young *Anodont*, a bivalve mollusc, attaches itself to its parent, or else to some fish, by a very long cable, which proceeds from the foot ; and which persists through life after its use is over in some mussels and *pinnæ*, and is known as byssus. In the gills of these *Anodonts* live the larvæ of some species of *Hydrachnidæ*, many of which are parasitic in the larval, but not in the adult state. Parasitism is common among other members of the *Gamasidæ* besides *Uropoda*, but its nature varies considerably ; in some cases the adult male, which is the most powerful and best developed creature, is not parasitic, although the females and young may be so ; and it is still a doubtful question whether these seek only conveyance from their host or actually feed upon his substance. Many arguments favour the latter view, but it is difficult to see how a whole swarm of *Gamasids* manage to find sufficient nourishment on the hard chitinous coat of such an animal as the common dung-beetle, *Geotrupes stercorarius*. Some *Gamasids* certainly seem to be true parasites ; thus many of those found on bees die if removed from the bee, while others do not. Two *Gamasids* which are unquestionably parasites, living all their lives upon the same host, and feeding upon him, are *Dermanyssus avium*, abundant in our poultry yards, and the *Pteroptus* of the bat, which latter is supposed to differ from all other *Acarina* in having an octopod larva ; an allegation which it seems to me must be received with caution. It shows how little the *Acarina* are understood even by first-rate naturalists ; that Van Beneden apparently supposes that *Pteroptus* does not belong to the order. Another quaint acarine parasite of the bat is the *Otonyssus*, a difficult creature to classify, which is generally found on the ears of the bat, most often three or four clinging to the extreme edge of the ear, and probably not any elsewhere. It seems odd that the numerous parasites of bats should be so very special. Neither *Pteroptus*, *Otonyssus*, nor the extraordinary *Nycteribia* have any very close allies elsewhere. Another curious acarine parasite of the bat, however, is in a different position—the *Myobia chiropteralis*—which was first described in a paper read at this Society, although a well-marked species, is closely allied to the

Myobia of the mouse and mole. It is interesting to find this relationship between the parasites of the mouse and bat, considering how closely-allied (zoologically) these creatures are, and how widely different are their habits. In the *Myobia* the front pair of legs are short, and armed, not with claws of the ordinary form, but with large, strongly-curved, chitinous blades, which curl round a chitinous peg, holding a hair of the mouse or bat between the two, and forming one of the most efficient organs for the purpose which I know of. In the *Listrophus* of the mouse and rat the hair is held by a somewhat similar apparatus, formed, not by the claw, but by the edge of the largely-developed and flexible maxillary lip; and, again, in the *Hypopi* of the *Glyciphagus* (*Dermacarus*) of the squirrel and the mole it is the recurved posterior edges of the dorsal and ventral plates, where they overlap, that perform the same office of holding the hair. Most, but not all of these are true parasites, living all their lives upon the same host, and feeding upon him. Very different in kind is the parasitism of the great sub-family of *Analginæ* or *Dermaleichi*, which live their whole lives upon the feathers of birds, and die if removed for any length of time; but they do not feed upon the substance of their host, they simply serve to keep his feathers clean; at least this is the opinion of those who have studied the group, and it is upon this fact that the name *Analges* is founded. The universality of the law was stoutly disputed by a South African ostrich farmer, with whom I once corresponded, who declared that the *Dermaleichi* increased in such numbers upon his ostriches that if the parasites were not killed (by sulphur, &c.) the birds died. If, however, they be beneficial, as is apparently the case in the majority of instances, they would then belong to Van Beneden's "mutualists," and not be classed by him amongst parasites at all. The number and variety of species in this group are very great; they are most imperfectly known, although the researches of Dr. Trouessart among the bird-skins in the French Museums have lately made us acquainted with a very long list of them. The occasional enormous development of one pair of legs, and the strange forms of the hinder extremity of the abdomen in the males of many of these *Acari*, would hardly be believed without being seen; but probably the most interesting circumstance about them is that the female is fecundated before the last change of skin, and that the egg-bearing

female is often totally different in appearance from the same creature at the earlier period when fecundation takes place. This has been called "Pedogenesis," and an instance of it occurs in a parasite which is not an *Acarus*. The crustacean once called *Praniza* is parasitic, and is fecundated at that stage, but it is the young of the free-living *Anceus*, and the eggs are laid in the latter condition. A curious connection exists between the *Dermaleichi* and another small group of *Acarina*, the *Cheyleti*; oddly enough, Van Beneden gives *eruditus* as the parasitic species. All the *Cheyleti* are predatory creatures, living on small, soft-bodied *Acari* and Insects, and are constantly searching for them. This leads the free-living kinds, of which *eruditus* is one, into all sorts of localities, and it has been described by authors who were not acquainted with its inquisitive habits as a resident in very strange places; but there is one small group of the *Cheyleti* which probably really may be called parasites; they are *Cheyletus parasitivorax*, *C. heteropalpus*, &c. These live permanently upon birds, but only to devour the *Analginæ*, by which the bird's feathers are infested. Here, says Mégnin, is an "auxiliary parasite," a sort of exaggerated mutualist, whose parasitism consists only in ridding his host of other parasites. This appears to be so, but if the *Analginæ* be really beneficial parasites the position of the *Cheyletus* may be considerably modified.

It is not only on the feathers of birds that acarine parasites exist. *Laminosioptes gallinarum* and *Cytoleichus sarcoptoides* live in the air-chambers, and on the serous membranes in such numbers as sometimes to kill the host, while the singular *Harpirhynchus nidulans* is found in the follicles at the roots of the quills, and the still stranger nymph of *Syringophilus bipectinatus*, with its tarsi terminated by a whole bunch of hooks, is found inside the quills themselves. There are plenty of other acarine parasites, but I will only refer to one which Professor Allman discovered in such an unexpected place as the nares of the seal. It is called *Halarachne Halichœri*, and has lately been carefully studied by Dr. Kramer.

I will now very shortly refer to a few only of the very numerous interesting parasites which are not Acari, but I shall wholly omit the intestinal worms, because, although these, from their life-histories, are the most curious of all, yet so much has been written about them of late, and so much said about them at this Society,

that the most singular facts are probably familiar to all my hearers.

Among insects, although the fleas of hairy animals are certainly parasites, yet I hardly think that the flea of man can be admitted into the fraternity; but there are two little incidents relative to this species which seem to me amusing. The first is that Van Helmont, an early writer, seriously gives a receipt for manufacturing them, as if they were pomade or cake; the second is that Van Beneden gravely discusses whether they might not advantageously be used instead of leeches, and whether it would be worth while for that purpose to import the very large specimens found at Cette and Montpellier. He appears to forget that the flea produces an irritation which people are foolish enough to object to. Possibly, however, he was only laughing at homœopathy. I have always thought that the *Ornithomyia* is a very curious parasite. It is a dipterous insect, with well-developed and serviceable wings, yet it lives a thoroughly parasitic life upon birds, only using its wings occasionally to shift from one host to another; but it can fly well. It is said occasionally to attack man, and a nocturnal incursion which a number of specimens made many years ago into the military hospital at Louvain created rather a panic among the inhabitants. Parasitic creatures are apt to be very imperfectly developed, but in this insect not only are the claws and mouth-organs powerful and complex, but also the internal organs are magnificently developed. I do not know any other dipterous species which makes so fine a slide for showing the optic and other ganglia, and the internal organs generally. The *Ornithomyia* has several near relatives which are not provided with wings, the ordinary sheep tick (*Melophagus ovis*), the *Lipoptena* of the stag, the *Braula cœca* of the bee, are allied creatures; but are all apterous. The *Ornithomyia* often exhibits a good instance of hyper-parasitism; the *Anoplura* and *Dermaleichi* of the bird frequently leave it and attach themselves in considerable numbers to the fly, where they appear disproportionately large. I do not think that parasites of parasites are so common as some people suppose. A *Hypopus* found on humble-bees is also found on the *Gamacids* which infest them. These two instances may be called accidental parasites, but Pagenstecher found Nematodes on the *Nicothoë* of the lobster, and the *Tœnia cucumerina* of the dog has

its temporary host in the *Trichodectes* of the dog; and probably there are plenty of instances amongst the entozoic worms.

Another dipterous parasite, which is amusingly quick in the ways of the world, is the *Tachinaria*. The fossorial *Hymenoptera* lay their eggs in burrows, and providently provide a store of the living larvæ of other insects, which they bury for their young to eat when hatched; but while the prudent mother is thus engaged the *Tachinaria* slips into the burrow, lays its eggs on the provisions, and departs. The dipterous larvæ are hatched first, so that before the young bee or wasp is born its larder is emptied, and the thief has gone forth rejoicing in its ill-gotten goods, and leaving its Hymenopterous neighbour to starve. Some of the *Hymenoptera*, however, are not easily excelled in the ingenuity of their parasitism. Mr. Enoch has often shown us his skilful preparations of the beautiful little *Polenema ovulorum*, which lays its eggs inside those of the common Cabbage-Butterfly. This charming little atom has a relative very like it, which has managed to adapt its fragile wings, with their long fringes, to an aquatic, or semi-aquatic, life; and lays its eggs inside those of the beautiful dragon-fly, *Agrion virgo*.

The crustacean parasites are very remarkable. It is chiefly among them that there occurs that strange form of parasitism—that while the female is a true parasite upon another animal, the male is practically parasitic upon the female; but, on the other hand, in *Nicothöe*, where the female has become a mere bunch of digestive and reproductive sacks, the male is a free-swimming creature. This degeneration of the female parasite into little more than an egg-sack is very remarkable amongst crustaceans, but is by no means confined to them; the same thing occurs with the mollusc *Entoconcha* and other creatures. Among strange crustaceans may be mentioned an Isopod *Bopyrus*, the female of which lives under the carapace of the prawn, the male being free, &c.; the *Phryxus paguri* discovered by Rathke, the female of which is found attached by its back to the abdomen of the *Pagurus*, thus sharing the shelter of the shell which the latter has taken possession of. The male of this creature is one of those that is parasitic upon the female. Another *Isopod*, the *Cymothöe*, lives in pairs, male and female, in the bucal cavity of fishes (*e.g.*, the *Stromatea*), not to devour its host, but to share his dinner. Those that live in

the mouth of the flying-fish are so large as to fill up the greater part of the cavity. Another *Isopod*, the *Icthyoxenus yellinghausii*, hollows out a comfortable residence for himself and his wife in the coats of the stomach of one of the cyprinoid fishes. The crustacean is said to penetrate from the outside, behind the abdominal fins, and through the skin. The *Pinnotheres*, a crab, lives in the mussel and other bivalves, and has been said to go out hunting, and bring his meals home with him and share them with his host ; this probably requires confirmation : if it be true, it certainly is quite opposed to some of the definitions of a parasite. The barnacles are very strange parasites. They do not usually want to feed on their host ; they only want to be carried into good places where they may fish for themselves ; and as creatures of this nature attach themselves in such numbers to rocks, to ships, to floating wood, &c., it does not seem very strange when we find some genera of them, as *Tubicinella*, *Coronula*, *Platylepas*, and *Chelonobia*, adhering to whales, sea-snakes, turtles, and even to the manatee ; but what does seem odd is that as a rule a species of barnacle adheres to one species of whale, and to that only. The *Gallæ* also are cirrihipedes. They are parasitic on crabs and lobsters, adhering to the abdomen, but have become so degenerate from their parasitism that they have but few organs left.

One of the worms, *Odontobius*, which also only desires to pick up passing scraps, seems to have a better idea of where to place itself on the whale than the barnacle has, for it is found on the whalebone, and a more favourable situation can hardly be imagined. A polyp, *Mnestra parasites*, has a very quaint notion of how to attain the same object, for it plants itself firmly on the head of a gasteropod, *Phyllirhoa bucephala*, and it caused considerable discussion among zoologists when discovered.

It is scarcely necessary to say that there are not any parasites, in my sense of that word, among the higher *vertebrata*, for that sense will not include either the vampire-bat, or the small Egyptian plover which keeps the teeth of the crocodile clean, or the *Piquebœuf*, which seeks its dipterous prey on the back of the buffalo ; but amongst fishes there certainly are cases very like parasitism ; these are mostly very well known. The *Remora* attaches itself by its suckers to a shark, or to some other fish which swims better than it does itself. The fishes *Fierasfer Hornei* and *Enchelyophis*

vermicularis live in the digestive cavities of holothurians. Fish live in sea-anemones, and *Oxybeles lumbricoides* lives in a star-fish; the young of *Caranx trachurus* frequent the cavities of the medusa *Chrysaora isocela*, and there are plenty of other instances of association between fish and medusæ. Some authors might call this parasitism, and some might not, but of one thing we may be certain, viz., that like all the other creatures which I have mentioned to-night, whether they be called parasites, messmates, mutualists, or anything else, they are not less wonderful nor less interesting than other forms of organic life, and that the study of them will amply repay everyone who has the time to devote to that pursuit, and the inclination so to devote it.

PROCEEDINGS.

NOVEMBER 11TH, 1887.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Freshwater sponge, *Spongilla fluviatilis* ...	Mr. F. W. Andrew.
Gizzard of Cricket	Mr. E. T. Browne.
Amœba princeps...	Mr. E. Dadswell.
Hydra fusca, with spermatic, and ovarian capsules	" "
Whirligig beetle, *Gyrinus natator*, showing aërial, and aquatic eyes	Mr. F. Enock.
Ephippian egg of Daphnia, resting stage ...	Mr. J. D. Hardy.
Group of Diatoms	Mr. G. Hind.
Eyes of fly, *Anthomyia*...	Mr. G. E. Mainland.
Actinoptychus annulatus	Mr. H. Morland.
Amphipleura pellucida, with Powell and Lealand's oil imm. achro. condenser, and Zeiss' apochromatic $\frac{1}{8}$ O.G. N.A. 1·40 and Nelson's eye-piece × 1,000 diam. Francis' method of intensifying by Nicol prism	Mr. E. M. Nelson.
Antarctic radiolaria, H.M.S. "Challenger," 1,950 fins	Mr. B. W. Priest.
Stephanoceros Eichhornii	Mr. C. Rousselet.
Section of Lily bud	Mr. W. Watson.

Attendance—Members, 49 ; Visitors, 4.

NOVEMBER 25TH, 1887.—ORDINARY MEETING.

A. D. MICHAEL, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. John J. Lewer was balloted for and elected a member of the Club.

The following additions to the Library and Cabinet were announced :—

"Proceedings of the Canadian Institute" ...	In exchange.
"Journal of the Essex Field Club"	"
"The American Monthly Microscopical Journal"	"
"Proceedings of the Belgium Microscopical Society"	"
"The Botanical Gazette"	"
"Proceedings of the New York Microscopical Society"	"
One Slide of *Cysticercus Cellulosæ*	From Mr. Smart.

The thanks of the meeting were voted to the donor.

The Secretary said it had often been found a matter of inconvenience when live objects were brought by members for distribution, that others were unable to take them home on account of not being provided with bottles. He had therefore asked the attendant to provide a supply of bottles, which members could purchase, if required, for 1½d. and 2d. each. Some small boxes for slides could also be obtained from him on similar terms.

Mr. C. L. Curties exhibited and described two new microscopes by Zeiss, one of which was furnished with a centering stage, rack and pinion to the condenser, and a clamping screw to the fine adjustment, by means of which it could be thrown out of gear and so saved from risk of injury whilst travelling; the other was mounted upon a triangular brass bar, which could be raised or lowered so as to alter the height of the body. It was also furnished with an iris diaphragm with ten leaves.

Mr. Curties also exhibited to the meeting some remarkable photomicrographs of *Pleurosigma Angulatum* and *Amphipleura Pellucida*, taken by Dr. Roderick Zeiss with the new apo-chromatic objectives.

The President hoped the members would examine these photographs after the meeting, as they were certainly amongst the most remarkable yet produced, certainly showing both longitudinal and transverse lines on *Pellucida*. The iris diaphragm was also worth attention.

Mr. Karop thought it was a most unfortunate thing to have added that very rough method of raising the body of the microscope. He could not see at all what was the good of it, and it would be sure to "wobble" after it had been a short time in use.

Mr J. D. Hardy exhibited a simple form of growing slide, in the construction of which he had used one of the ordinary compressors. It was intended as an intermittent slide, since the circulation had to be stopped whilst the contents of the slide were being examined under the microscope.

The thanks of the meeting were voted to Mr. Curties and Mr. Hardy for their communications.

Mr. B. T. Lowne gave a *resumé* of his paper "On the Histology of the Muscles of the Fly," which he freely illustrated by drawings on the blackboard.

Prof. Chas. Stewart said he had listened with much pleasure to the clear and lucid manner in which Mr. Lowne had explained his subject, and had laid before them certain views concerning it. For his own part, not having made muscle structure a study for many years past, his knowledge of it was probably somewhat antiquated; but regarding the subject from the standpoint of his own sub-fossilized views, he should rather have fancied that what had been spoken of as nutrient-plasma was really continuous with the protoplasm on the surface. He should look upon this largely as being protoplasmic, and that all the other was but a modification of it. He should also be disposed to think of the complex parts as being derived from a modification of the cell rather than from the nucleus. He thought, too, that this protoplasm was no more nutrient than the other, though it was no doubt

likely that nutriment might be diffused through it, regarding it as the living material of the structure. A little doubt seemed to have been thrown by Mr. Lowne as to the existence of Krause's membrane, but he thought this was quite plainly to be seen, and that there was no difficulty in showing it. Having drawn a diagram upon the board, he pointed out that a fibre showed dark and light portions as described, and that in the dark portion a middle dark line could very readily be demonstrated—this was Krause's membrane. He thought it was certainly not due to any optical effect, but to the existence of a different material, and that the rods were separated by a more abundant quantity of plasma. In each little group of these rod-like structures there was another differentiation producing light patches, which were probably due to more or less fusiform expansions. He had not seen any evidence of the continuity of the rods across the clear spaces. Here they always seemed to be interrupted, the clear space being crossed by Krause's membrane. He thought, however, that he should only be expressing the feeling of the members of the Club, as well as his own, by hoping that Mr. Lowne would give them a demonstration of the subject on one of their gossip nights, in which case he should be very pleased to bring up some of his ancient specimens for comparison.

Mr. Karop thought the evidence as to the existence of Krause's membrane was not very conclusive. The fact that a small nematode worm had been seen to crawl up inside a fibre, the substance of which closed up again after it, seemed to show that this so-called membrane was not a membrane at all in the general sense of the term.

Professor Stewart thought this would be quite possible supposing the membrane to be viscous and not solid. In such case a nematode might pass through just as a penny could pass through the film of a soap-bubble without rupturing it, or as white blood corpuscles passed through tissues. There was no need to suppose that the worm passing through necessarily made a hole, except in the sense in which a suicide was said to "make a hole in the water."

Mr. E. M. Nelson said he had been examining muscular fibre, not with any idea of studying it physiologically, but just to see what could be done with it optically. For this purpose he took a portion of the muscle of a pig and selected an ultimate fibril measuring in section not more than the $\frac{1}{11000}$ inch, and in which, if the bands were all the same size, they would have measured the $\frac{1}{88000}$ inch. Drawn upon the black-board, he showed that this fibril was crossed by a number of lines, some being white, others dark, black, or very black, and so fine that in some cases they almost appeared beaded.—It was a fact that some people always saw beads in a horizontal line if only it was fine enough. He tried this object just in the same way as he did diatoms, and was quite sure that there were no continuous vertical lines running down it, but there was something of a waxy appearance, which might divide it into three.

Mr. T. F. Smith said he had no physiological knowledge of the subject, but he had examined an ultimate fibre, the diameter of which was about the $\frac{1}{50000}$ inch, and drew on the board the appearance which it presented to

him. He quite agreed with the remark that when a person looked at fibres of this sort in large bundles he could make anything he liked out of them.

The President said he had been greatly interested in this paper and in the discussion to which it had given rise. It was well known that Mr. Lowne had devoted himself largely to insect anatomy, so that the points raised were of extreme interest. Personally, however, he could add nothing to what had been said, as the subject was one which was outside his own department of study. If he recollected rightly there was a reference to it in Professor Schäfer's anatomy of a fly's leg, where it was stated that in the duller bands there were certain rod-like substances which had highly refractive, somewhat swollen ends, lying in the lighter bands, and his view was that these were detached structures lying within the darker band, the enlarged ends appearing as black spots in the lighter band, so that in each lighter band there was a double row of dots. He also mentioned that during the contraction of the muscle, when the lengths of the rods shortened, the size of the darker spots increased considerably, so that the light band became a dark band in consequence of the greatly increased size of the dark ends. His view was that these rods were entirely detached from those of other bands, and were not connected by any intervening lines as Mr. Lowne had shown. If, however, Mr. Lowne could demonstrate what he had described it would be a highly interesting addition to their knowledge of the minute structure of muscle.

Mr. B. T. Lowne said, with regard to the appearances which were found in minute structures of this kind, everyone would, of course, take his own view of what he saw. For his own part he regarded them largely as interference phenomena, and in this opinion he was certainly strengthened by what Mr. Nelson had stated to be the result of his observations. They would find that there were a hundred different opinions as to what these appearances meant. They had been described over and over again, and they were so exceedingly minute that he could not place much importance upon observations upon muscle of ordinary mammals. Neither should he insist strongly upon what he saw in the muscles of the fly, except for the fact that the wing muscles were ten or fifteen times as large as those of any mammalian. It had even been said that they were resolvable into minute fibrillæ, and there was so distinctly a continuous line that he had no doubt whatever as to its existence as a fact. With regard to nutrient material, perhaps it was rather a popular mode of expression, but he regarded the functional part as represented by the longitudinal bands, and thought the material which kept them going was perhaps the protoplasm. He thought it was now universally admitted that muscle nuclei split up into rods. This might be wrong, but it was certain that the nucleus gradually disappeared under the formation of the rods; and it seemed, therefore, as if there must be something analogous between the two formations. What he meant to say was that the nucleus was concerned somehow in the formation of the rods, and it was quite certain that the nucleus disappeared and the rods took its place. What he wanted shown was that diffraction could not account for the appearances. The structure which he had observed appeared at least to be

mechanically possible, and there seemed no doubt whatever that the transverse markings were an index of the rapidity with which the muscle was capable of contracting.

The thanks of the meeting were then unanimously voted to Mr. Lowne for his communication.

Mr. T. F. Smith read a paper "On the structure of Moth and Butterfly Scale," supplementary to that read at the previous meeting.

The thanks of the Club were voted to Mr. Smith for his paper.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, and the following objects were exhibited :—

Volvox with parasitic rotifer, *Proalis parasitica*	Mr. F. W. Andrew.
Floscularia ornata	Mr. E. T. Browne.
Photo-micrograph, Spine of *Echinus*, taken with Baker's 2in. O.G.	Mr. C. Lees Curties.
,, *Amphipleura pellucida*, partly resolved into beads, sent by Dr. Zeiss, and taken with his 3·0 mm. apochromatic O.G. N.A. 1. 30.	,,
,, *P. angutatum* × 4900 from Dr. Zeiss, and taken with his 2·0 mm apochromatic O.G. N.A. 1.30	,,
Head of "Devil's coach-horse" beetle, *Ocypus olens*, with drawing ...	Mr. F. Enock.
Section of eye of Blowfly, prepared by Mr. Underhill	Mr. H. E. Freeman.
,, eye of *Pieris brassica*, do. do. ...	,,
,, eye of Spider, do. do.	,,
Circulation in *Anacharis*	Mr. G. Hind.
Fresh-water *Oligochæta*, sp.	Mr. G. E. Mainland.
Rotifera, various	Mr. C. Rousselet.
Scale of Moth, *Urania rhypheus*, showing villi	Mr. T. F. Smith.
Type slide of diatoms from Oamaru	Mr. W. Watson.

Attendance—Members, 48; Visitors, 3.

December 9th, 1887.—Conversational Meeting.

The following objects were exhibited :—

Stichotricha remex	Mr. F. W. Andrew.
Actinomycosis, in tongue of Cow	Mr. C. Lees Curties.
Fairy fly, *Camptoptera papaveris*	Mr. F. Enock.
Beetle, *Mezium sulcatum*	Mr. G. E. Mainland.
Hemiaulus amplectans	Mr. H. Morland.
Raphidiophrys elegans	Mr. C. Rousselet.
Ultimate muscular fibre of Pig	Mr. T. F. Smith.
Beetle, *Ptilinus pectinicornis*	Mr. W. Watson.

Attendance—Members, 38 ; Visitors, 7.

December 23rd, 1887.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. W. Barnes, Mr. Fredk. Goslett, and Dr. G. W. Royston-Pigott.

The following additions to the Library and Cabinet were announced :—

"The Botanical Gazette"	In Exchange.
"The American Monthly Microscopical Journal"	"
"Proceedings of the Canadian Institute of Toronto"	"
"The American Naturalist"	"
"Science Gossip"	From the Editor.
"Journal of the Royal Microscopical Society"	From the Society.
"Proceedings of the Royal Society"	" " "
"Annals of Natural History"	Purchased.
"Grevillea"	"
Twenty-four Slides prepared by Mr. Hinton...	From Mr. T. F. Smith.

The thanks of the Club were voted to the donors.

The Secretary called attention to a prospectus recently received from the publisher of the "Naturalists' Directory," Boston, Mass., U.S.A., accompanied by a request for names suitable for insertion with particulars as to the special branch of science taken up, and whether it was desired to make exchanges of specimens, &c. It appeared to him that for some purposes this would be found a very useful book.

The President said that this was no doubt a very useful publication to naturalists, who could by its aid ascertain the names and addresses of

persons in all parts of the world who were working at the same subjects as themselves, and with whom they could, if they desired, readily place themselves in communication.

Mr. H. Morland read the following extract from a letter dated December 19th, 1887, from Herr E. Weissflog, of Dresden:—"Among the diatoms picked out from the Oamaru deposit I had one small frustule of *Craspedoporus elegans;* when dry it was difficult to see the different structure of both valves. Before mounting it I passed it in a drop of water; the latter soaked into the frustule and both valves separated readily. They confirm fully your view about this form; one valve is *Craspedoporus elegans*, the other *Porodiscus interruptus*."

Mr. Karop thought it was very interesting that Mr. Morland's observation should have been confirmed in that way. When looking at the specimens at the time they were exhibited in illustration of the paper, he had remarked that they seemed to be too good a fit to be the result of casual occurrence.

The thanks of the meeting were voted to Mr. Morland for his communication.

Mr. T. F. Smith read the following supplementary note to his paper on "Butterfly and Moth Scales" read at the ordinary meeting of the Club in November last:—"It was not my intention to have said anything more on 'Butterfly and Moth Scales,' but since reading my last paper I have found in the 'Monthly Microscopical Journal' a paper read before the Royal Microscopical Society on May 3, 1871, by Dr. R. L. Maddox, in which he treats the subject somewhat exhaustively and arrives at the same conclusion as myself as to the nature and use of the little rod-like bodies between the membranes. His language is as follows: Speaking of the two membranes, he says—'The inner was made up of a coarser and darker material with also pigmentary deposit, in the substance of which the framework of the longitudinal ribs is fixed, projecting somewhat on the free surface of the membrane facing the opposite one; but besides this, the longitudinal ribs especially, if not the cross-bars, appear to be attached to the opposing surface of the outer, or next membrane if three, by minute more or less wider or narrower vertical projections or septa—so that the ribs are bound to each other by cross-bars and to the opposite membrane by short columns or attachments at very different points.' Now, of course I should have found this out before reading my last paper instead of after, and my only excuse is that there is no indication of this structure in the three plates that accompany the paper, and coming so soon after Mr. McIntyre, who figures the structure but calls it false, I did not read the letterpress until too late. I am sorry that I should have treated this presence of the rod-like bodies to keep the two membranes apart as a new discovery, and take this earliest opportunity of acknowledging my mistake."

The President said that no one could avoid occasionally putting forward as new something which had already been published, because an exhaustive search of all that had been published on any subject was for most persons a matter of impossibility. When, however, such a thing had occurred the proper thing to do was what Mr. Smith had done—but which persons of

great note sometimes omitted—namely, to take the earliest opportunity of acknowledging the fact in the same place as that in which the statement had been made.

The President said that as there were no other papers before the meeting he would say a few words about a slide which he had brought down for exhibition. The object was not one which he had seen put up as a microscopic object, and although it was a very common thing and was shown in almost every biological work, it was not everyone who had seen the thing itself—he referred to the Spermatophore of one of the *Cephalopoda*—the common Squid. These creatures were common on the extreme western coast of England during the late summer and autumn, at which time they appeared to come in shore, and were then eagerly sought for by fishermen on account of the value attached to them as bait. Having described the process usually adopted in fishing for Squid, the points of interest connected with the specimen exhibited were illustrated by a diagram drawn upon the black-board.

Mr. Morland inquired what medium was employed for mounting this object.

The President said the best thing for the purpose was diluted glycerine or glycerine jelly.

Professor Chas. Stewart said he quite agreed with the President that this was an extraordinarily beautiful object, and one also very full of interest. It could be readily obtained from the common Squid, and when mounted in glycerine jelly and illuminated with a parabola or spot lens its features were brought out exceedingly well. It was worth mentioning, however, that glycerine jelly had an inconvenient way of developing large vacuoles in the middle of the slide, which in course of time necessitated remounting. Some year or two ago specimens of this object could be obtained stained and mounted in balsam—he believed they came from Zoological Station at Naples—but when prepared in this way they were certainly not such beautiful objects. Perhaps the most remarkable Spermatophore was that of a small species of *Tremoctopus* from the Mediterranean, which had about 100 suckers close together upon the hectocotylus. On examining one of these he found a rather remarkable thread, which was sticking out from the great respiratory orifice. On tracing it, it was found to come out of the genital opening, and on being drawn out he found it extended to a length of two feet, and at one end there was the special armature which had been described by the President. He thought it was rather an extraordinary thing to find one of such remarkable dimensions, especially in the case of one of the smallest of the Octopods.

Mr. Karop said that though the President had mentioned the chief use made of these creatures here was for the purpose of bait, on the Italian shores the people ate them with avidity, and also sold them as food. He moved a vote of thanks to the President, which was unanimously carried.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual conversazione, and the following objects were exhibited :—

Cordylophora lacustris	Mr. F. W. Andrew.
Crystals of Acetanilide	Mr. E. T. Browne.
Achyla prolifera, on dead larva of *Corethra plumicornis*	Mr. G. E. Mainland.
Spermatophore of Squid, *Loligo vulgaris* ...	Mr. A. D. Michael.
Muscular fibril of Pig	Mr. E. M. Nelson.
A collection of various Rotiferæ	Mr. C. Rousselet.
Scale of Moth, *Callimorpha dominula*, showing villi	Mr. T. F. Smith.

Attendance—Members, 36; Visitors, 2.

January 13th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Crystals on cork of sherry wine bottle ...	Mr. F. W. Andrew.
Eggs of Sea Loach	Mr. E. T. Browne.
Chelifer, sp.	Mr. J. J. Kern.
Bugula turbinata	Mr. G. E. Mainland.
Triceratium Weissflogii	Mr. H. Morland.
Nest of Trap-door Spider, from California ...	Mr. S. H. Needham.
Exuvia of *Dermestes* larva	Mr. E. M. Nelson.
Photo-micrographs	„ „
Entomostraca, *Bosmina longirostris*	Mr. C. Rousselet.

Attendance—Members, 28; Visitors, 2.

January 27th, 1888.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. W. S. How was duly elected a member of the Club.

The following additions to the Library and Cabinet were announced :—

"The Microscope," Nägeli and Schwendener...	From Mr. Frank Crisp.
"Essex Dene-holes"	„ Essex Field Club.
"American Monthly Microscopical Journal"	In Exchange.
"Botanical Gazette"	„
"Journal of the New York Microscopical Society"	„
"Journal of Microscopy"	„
"Journal and Proceedings of the Royal Society of New South Wales" ...	„
"Proceedings of the Eastbourne Natural History Society"	From the Society.
"Proceedings of the Belgium Microscopical Society"	„
"Annual Report of the Ealing Natural History and Microscopical Society"	„

"Science Gossip"	From the Publishers.
"Annals of Natural History"	Purchased.
Ten Slides from Mr. E. T. Browne	

The thanks of the Society were voted to the donors.

The President said that, as the next ordinary meeting would be their Annual Meeting, it would be necessary according to their rules to elect auditors of their accounts, and also to nominate members to serve on the Committee for the ensuing year.

The Secretary then read the following list of nominations on behalf of the Committee:—As President, Prof. B. T. Lowne; as Vice-Presidents, Messrs. Michael, Stewart, Newton, and Nelson; the other officers as before; also as Auditor, on behalf of the Committee, Mr. W. Hainworth, jun.

The President said that the four members of the Committee who would retire this year in accordance with the rules were Messrs. White, Priest, Waller, and Hembry, all of whom were eligible for re-election. He then invited the members to nominate four gentlemen to fill the vacancies thus created, and also to appoint an auditor on behalf of the members.

The following nominations were then made as members of committee:—

Mr. Hembry,	proposed	by Mr. Dadswell,	seconded	by Mr. Vezey.
Mr. Priest,	,,	,, Mr. Hind,	,,	,, Mr. Dadswell.
Mr. Waller,	,,	,, Mr. Rousselet,	,,	,, Mr. Western.
Mr. T. C. White,	,,	,, Mr. Thos. Curties,	,,	,, Mr. Vezey.

Also as auditor, on behalf of the members, Mr. F. H. P. Hind, proposed by Mr. Turnbull, seconded by Mr. T. Curties.

The names of the two gentlemen proposed as auditors (Messrs. Hainworth and Hind) were then submitted to the meeting by the President, and declared duly elected by show of hands.

Mr. E. M. Nelson read a paper "On the Formation of Diatom Structure," illustrating the subject by a series of photomicrographic positives, exhibited on a screen by lantern.

Mr. Morland said he had himself observed that when the round dots on the diatom valves became closer they seemed as if they were plastic, and so, by being pressed closer, they became polygonal.

The President thought the meeting was greatly indebted to Mr. Nelson for the very interesting exhibition which he had given, and also for the very clear way in which he had traced out the processes of formation in those cases he had mentioned.

The thanks of the meeting were then voted to Mr. Nelson for his communication.

A paper by Dr. G. W. Royston Pigott, F.R.S., "On the Beaded Villi on Butterfly Scales," was read by Mr. Thos. Curties, the subject being illustrated by diagrams, and a number of preparations sent for the purpose by Mr. Hinton, and Mr. Watkins, of Painswick, and exhibited by means of electric lights provided by Mr. J. T. Niblett.

Mr. T. F. Smith said that he thought some of the appearances described in this paper were due to the villi being seen out of focus. He thought they were in between the two membranes of which the scales were composed,

that their use was in keeping the two surfaces of the scale apart, and they were longer or shorter according to whether the surfaces were more or less rounded. He had seen some of the appearances, but only by taking too deep a focus. As for the beading, he had never seen it, and he was strongly inclined to the belief that it arose from Dr. Pigott's methods being in some way at fault. He believed from what he had read that Dr. Pigott worked with a very small aperture, and if anyone wanted to produce false appearances they could not go a better way to work; and by using the lowest aperture of the condenser the same effects could be produced. With regard to the test rings, he knew that appearance perfectly well; but it was again a false effect due to the results of using too small an aperture.

Prof. B. T. Lowne said he had not given very much attention to this subject, and therefore did not feel competent to enter very fully into it; but his own impression was that the lepidopterous scales consisted of two membranes united, or rather kept apart, by vertical rods passing between the two. With regard to their origin, that of course was a different question altogether; but he was inclined to think that they were mostly regular and had no morphological value whatever.

The President said that he had no doubt whatever that in the case of some of the scales of lepidoptera there were two surfaces resembling a very much flattened sack, and that these surfaces were joined together by pillars. Of course this fact could not be considered to prove that the surfaces were necessarily flat, neither did he suppose that there were not also small pillars upon the surface; but that they were attachments inside was a thing he had very little doubt about, although he should say that he had not investigated the minute structure of butterfly scales.

The thanks of the meeting were voted to Dr. Pigott and Mr. Curties, also to Mr. Niblett for his assistance in exhibiting the specimens.

Mr. J. T. Niblett, by invitation of the President, exhibited and described the electric lamps which had been used upon this occasion. They were of the ordinary type of incandescent lamps with carbon filaments in vacuo, but the novel and interesting feature about them was due to their being worked by the new Schanschieff primary battery, which not only went into a small compass, but would efficiently afford the necessary current for ten hours with once charging. The remarkable energy of this battery was chiefly due to the exciting fluid (a strong solution of sulphate of mercury), which, being decomposed by the action, ultimately resolved itself into sulphate of zinc and metallic mercury, the latter being a valuable product, and one which, by its reconversion into sulphate, could be used repeatedly, whilst 1oz. of the solution would furnish an equivalent of two hours' work with an electromotive force of 1·39 volts. The microscope lamp exhibited was fixed upon the outside of a small mahogany case, which contained a battery of four cells. When the light was required the battery plates were lowered into the solution, and the carbon filaments at once glowed with full intensity. The chemical action being somewhat powerful, it was necessary to raise the plates from the fluid when the light was no longer required. At the end of ten hours the solution would require renewing, and new zinc plates would be

occasionally needed; but the light was well maintained throughout, and could, with great facility, be used for any time from a few moments to the full extent to which one charge would last. To show the quantity of current furnished, six small lamps connected in parallel were placed in the circuit, and the whole were efficiently lighted in a way not achieved by any primary battery of the same size hitherto introduced. A reading lamp of somewhat greater illuminating power, worked by eight cells, and the further application of the principle to miners' lamps were also exhibited. In the latter the lamp was enclosed in the centre of the case, and protected by a bull's-eye lens. At one end the battery plates were fitted in a hermetically closed chamber, whilst at the other was a similar space containing the fluid, the two communicating by means of suitable tubes. When the end containing the plates was held uppermost the fluid naturally occupied the lower chamber, and no action took place; but on inverting the case the solution ran through the tubes, and, coming in contact with the plates, put the battery at once into operation and lighted the lamp. The great superiority of the light thus produced, as compared with the best of the Davy lamps, was pointed out; absolute safety being also secured, and this at a cost for solution equal to about one penny for ten hours. In reply to questions, Mr. Niblett stated that the carbon filament of the lamp was calculated to last out 2,000 working hours; also that he believed the cost of a battery and lamp complete would be about three guineas, though at present the invention was only being introduced preparatory to its manufacture on a large commercial scale.

The thanks of the meeting were heartily accorded to Mr. Niblett for his exhibition and explanations given.

Mr. Thos. Curties said he believed it had been generally felt that the ordinary meetings of the Club which took place in July and August occurred at a time when it was very inconvenient for many members to be present, and as a consequence they were not largely attended. In order to remove the difficulties which had been increasingly felt with regard to these meetings, he gave notice that at the ensuing annual meeting he would propose such alterations in rule 1 as would allow of those meetings being held as gossip nights instead of ordinary meetings.

Mr. Willson seconded the notice of alteration.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, the following objects being exhibited:—

Living larva of Mayfly...	Mr. F. W. Andrew.
Actinosphærum Eichhornii	Mr. W. R. Browne.
Antheridia and Archegonia of *Chara* ...	Mr. H. A. Crowhurst.
Scales of Moth (*Zygæna*)	Mr. T. Curties.
Utricularia	Mr. E. Dadswell.
Rotifers, various	Mr. C. Rousselet.
Scale of *Podura*	Mr. T. F. Smith.

Attendance—Members, 49; Visitors, 5.

REPORT OF THE COMMITTEE.

FEBRUARY, 24TH, 1888.

With the publication of its Twenty-second Report, your Committee is enabled to give a satisfactory account of the Club's affairs for the past year.

Its financial position is sound, and the contributions have not been behindhand in quality or usefulness. In numbers, however, there is some diminution. Twenty-four new members have been elected since the last Report, twenty-nine have resigned, and six have died, leaving a total of 443 now on the books of the Club, exclusive of honorary members.

The papers and communications submitted to the meetings have been numerous and interesting.

The following is a list :—

1887.

Mar. 25. "On the Calcaria," by Mr. B. W. Priest.

" "On the structure of Aulacodiscus margaritaceus," by Mr. Morland.

April 22. "On Mounting Media," by Mr. Morland.

" "On Diatom Parasites" (Dr. Zopf), translated by Mr. Karop.

May 27. "On Spiders," by Mr. Underhill.

June 24. "On the Development of the Blow-fly's Proboscis," by Mr. Lowne.

" "On Diatom Structure," by Mr. T. F. Smith.

July 22. Papers by Messrs. Smith, Davis, and Morland.

Aug. 26. "On Orthesia found at Kew Gardens," by Mr. Brown.

Oct. 28. "On the finer structure of Butterfly and Moth Scales," by Mr. T. F. Smith.

Nov. 25. "On the Histology of the Muscles in the Fly," by Mr. Lowne.

Particular reference should be made to the continuation of the valuable papers by Messrs. Grove and Sturt, "On the Diatoms of the Oamaru Deposit," which have appeared in the Journal. This is one of the most important contributions to the literature of the subject which has been published for some years, and the Club is indebted to the liberality of the authors for a part, at least, of the profuse and excellent illustrations which accompany it.

Several new forms of microscopes photo-micrographic, and other apparatus were exhibited and described at the meetings, full accounts of which, with other matters of interest, are printed in the Journal.

The following is a list of the books added to the Library during the year :—

Hooke's "Micrographia Restaurata"	Mr. C. J. Leaf.
"My Microscope," by a Quekett Clubman	The Author.
"Naegeli and Schwendener on the Microscope" ...	Mr. F. Crisp.
Dr. Braithwaite's "British Moss Flora." Part 10 ...	The Author.
Smithsonian Report, Part 2. 1884	U. S. Government.
,, ,, Part 1. 1885	
"Journal of the Royal Microscopical Society" ...	The Society.
"Proceedings of the Royal Society"	,, ,,
"Science Gossip"	The Publishers.
Dr. Cooke's "British Desmids," completion... ...	Purchased.
Nelson's "Bryologia Britannica"	,,
Strasberger's "Practical Botany"	,,
Lee's "Microtomist's Vade Mecum"...	,,
"Challenger Zoological Reports." Vols. 17-21 ...	,,
" ,, Botanical Reports." Diatoms ...	,,
"Quarterly Journal of Microscopical Science" ...	,,
"Grevillea"	,,
"Annals and Magazine of Natural History" ...	,,
"American Naturalist"	In Exchange.
"American Monthly Microscopical Journal" ...	,,
"Journal of Microscopy"	,,
"Scientific Enquirer"	,,
"Botanical Gazette"	,,
Buckler's "Larvæ of British Butterflies and Moths." Vol. 2...	Ray Society. By Subscription.
Proceedings of various Societies and Sundry Pamphlets	Presented.

It has been found impossible to issue a supplemental list or revised catalogue of the Club's books, as promised in the last Report, owing to the difficulty the Committee has encountered in

obtaining sufficient accommodation for the existing Library. This difficulty is now, however, in a measure solved through the kindness of Mr. J. G. Waller, who has placed a room in his house at the disposal of the Club. In this room the Committee propose storing such volumes, unbound parts of periodicals, &c., as are in least demand ; a list of these will be kept by the Librarian, and any of them can be obtained by giving notice at a previous meeting.

These volumes have been included in the Club's policy of insurance.

The thanks of the Club are due to Mr. Waller for this privilege, which will materially lessen the perplexity and lighten the labour of our Hon. Librarian, Mr. Alpheus Smith.

The following slides have been presented to the Cabinet :—

Mr. T. Curties	12
,, W. Smart	1
,, T. F. Smith	24

By permission of the College authorities, a Special Exhibition Meeting will be held on the second Friday in March, full notice of which has been sent in due course to all members.

The attendance at the Excursions and the specimens secured were fully up to the average of former seasons, but nothing extraordinary was recorded. The day excursion to Whitstable, owing mainly to the kind services of Mr. Sibert Saunders, was greatly enjoyed by a numerous party.

The Journal of the Club, under the editorship of Mr. Hailes, has been kept up to its usual standard ; but members are reminded that a constant supply of contributions is necessary, if it is to retain the reputation it has already acquired.

The Council of the College have again accorded to the Club the privilege of holding its meetings in the Library.

Your Committee further desire to thank the Treasurer, Secretaries, Reporter, Librarian, and Curator for the services they have rendered in carrying on the business of the Club,

They trust finally that the past history of the Club will act as a stimulus to future efforts, and that it may long continue to flourish.

TREASURER'S STATEMENT OF ACCOUNTS.

Dr.

		£	s.	d.
To	Balance in hand, Christmas, 1886	130	13	7
	Subscriptions since received	180	6	0
	Dividends on Money Invested	4	6	2
	Sale of Journal	6	0	5
		£321	6	2
To	Balance in hand	149	8	11

Cr.

		£	s.	d.
By	Postage and Carriage	4	18	6
	Printing and Stationery	7	14	5
	Attendance, Lighting, and College Expenses ...	21	2	0
	Petty Expenses	2	9	6
	Property Purchased	23	10	3
	Journal Expenses	112	2	7
	Balance	149	8	11
		£321	6	2

Amount invested in New Three Per Cent. Annuities, £140.

We, the undersigned, having examined the above statement of Income and Expenses, and the Vouchers relating thereto, hereby certify the same to be correct.

WM. HAINWORTH,
F. H. P. HIND, } Auditors.

Dec. 31st, 1887.

Notes on Marine Aquaria.

By H. J. Waddington.

(*Read March 23rd*, 1888).

I should hardly have ventured to read a paper on Marine Aquaria did I not know that the subject is an interesting one to many members of this Club. I must admit that there are two objections which may be fairly raised : the first that it is hardly microscopical, and the second that so much has been already said and written that it is a little threadbare. To the first of these I should reply that although the primary intention of keeping Marine Aquaria may not be microscopical, yet if the keeping them is successful there is very much to be found that is interesting to microscopists, and that from the few opportunities we in London have of studying marine zoology in its minuter forms, the life which is developed is comparatively new to many of us. I cannot give you a better illustration of this than by instancing the specimen of *Hydra tuba* which I had the pleasure of exhibiting at our special evening meeting. From the happy accident of this having developed on a loose stone I have been able to watch it for many months. Seen at our meeting in a small bulk of water, which was constantly shaken by the passing to and fro, the tentacles of the Hydra were not fully expanded, but when at rest in the aquarium they are in some cases fully 1½ inches in length. They are constantly budding, so much so that the glass vessel on which the stone rests is dotted all over with small Hydra. A few months before their appearance the vegetation in the same aquarium (an ordinary bell-glass) contained the beautiful *Freia elegans* in considerable quantity, and a specimen of *Tubularia indivisa*, brought from our Whitstable excursion in 1886, is still flourishing. I might instance many more interesting finds, but I think I have said enough to show that the subject is at least collaterally microscopic.

The remarks I have to make this evening deal with Aquaria intended for Actinia and allied forms of life, and I desire that they may be taken not as directions for aquarium keeping, but as illustrations of what may be done under circumstances which are

usually considered as adverse to success, for all my Aquaria are placed (from the force of circumstances) in what the books usually tell us is the worse possible aspect, viz., south-west. They are in a conservatory the temperature of which has frequently been 80° in the summer months, and they are all of the wrong shape.

The first consideration is the sea-water. This may be obtained of most excellent quality of the Great Eastern Railway Company. Since it has been supplied in wooden kegs I have always found it brilliant to the last drop, and as the Company deliver three gallons for sixpence within a reasonable distance the first difficulty is readily got over.

In starting a Marine Aquarium I proceed as follows: Procuring a bell-glass of the required size I cut a piece of stout paper or card that would slope at an angle of about 45° from the bottom of the aquarium to about one inch from the top. The shape will be something of this figure U. A piece of common stout glass must be cut to this pattern, and this forms the back of the aquarium. It rests at the bottom on two wedge-shaped pieces of cork, two or three similar pieces being placed between the edges of the glass and the sides to relieve the pressure. The aquarium is now filled with sea-water, a small piece of green sea-weed introduced, then covered with a piece of fine muslin and exposed freely to light and air. The stones or rockwork material are similarly exposed in another vessel. In the course of a few days the inner surface of the aquarium and the back and front of the piece of glass are covered with vegetable growth. When this is in sufficient quantity the water is emptied out, the part of the aquarium in front of the glass plate carefully wiped clean, and the stones and rock placed in position. When the water is returned to the aquarium it should be poured down the clean side so as not to disturb the vegetation. Two strips of paper are to be pasted at the exact level of the water, on opposite sides, to enable the amount of evaporation to be seen, and compensated for by the addition of fresh water. The aquarium, assuming it to be kept for Actinia, should always be closely covered with a piece of glass overlapping the edges by half-an-inch. This cannot be too strongly insisted on. If it is required to start an additional small aquarium for any purpose, as for isolating individual specimens, it is only necessary to remove a few stones covered with vegetation from the larger aquarium, and to use the water which has become established in this, replacing it by fresh

sea-water poured in at the back. It is of great advantage to have an extra supply of water. If this is kept in a vessel with fair exposure to light the vegetation which will be formed on the sides will keep it in good condition, and if it becomes necessary to change the water in an aquarium, the bad water may take the place of the water in this stock vessel and will be found in a few hours to have become perfectly good.

The rockwork for Aquaria, whether made or purchased, requires prolonged soaking in sea-water, once or twice renewed, before it is fit for use. In such a one as I have described, made up rockwork is not requisite, but if desired it should be formed of rock and pumice-stone held together by Portland cement, due care being taken that the density of the rockwork as a whole is greater than that of sea-water. A rockwork that sinks readily in fresh will often float in sea-water.

It is an erroneous idea that Marine Aquaria require to be of considerable size. The chief advantage of a large aquarium is that it is less likely to be affected by sudden changes of temperature, a larger volume of water naturally requiring more time to become of the external temperature than a smaller volume. Apart from this there is really no limit to the smallness of a perfect aquarium. Many methods will suggest themselves to obviate the difficulty of keeping small Aquaria through the great heat of summer. They may be easily moved into cooler places, while such as are made out of small glass jars, or even ordinary glass tumblers, by readily devised means may be made to float in a larger Aquaria or in pans of ordinary water. By covering the outside with wet flannel, of which a portion is allowed to dip in a vessel of water to ensure constant moisture, I have kept Aquaria perfectly when the heat for days together has been 80°.

One difficulty is to keep the vegetation within reasonable limits, and to effect this shading from too strong a light must be resorted to. Green baize or some similar material is very useful, but I have found that even with this the vegetation grows too much. Probably a yellow material would have a better effect in checking the growth. I find it more advantageous to allow the vegetation a fair amount of development and to remove it from time to time if excessive, for where there is vegetable vitality, animal vitality follows, and if the vegetation is deficient the animals are sluggish.

Aeration is not a necessity in a well-ordered aquarium, but is

very useful for bringing to the surface any particles of floating or decomposed matters, and for giving a stimulus to animals that are sluggish. For some Actinia, such as *Anthea cereus*, it is indispensable, and it must certainly afford a nearer approach to the conditions of their natural habitat, the sea, than to allow them to remain constantly at rest. The syringe used should always be pulled apart and left open after using, otherwise it will smell very offensively.

Well agitating the whole of an aquarium occasionally I have found exceedingly beneficial; I cannot better describe this than by a "thorough stir up." It is a very heroic remedy, and I can quite understand exception being taken to it, but the healthiest aquarium I have, and the one which contains the most animal life in proportion to its size, and in which the inhabitants breed most freely, is the one which undergoes this process frequently. After well stirring it up I pass a muslin net through it for some minutes; this retains the greater portion of the floating matter. I then syringe it well and in a few minutes the surface is covered with *débris* brought up by the fine bubbles of air. These are removed by the net. The water is then very thick, but improves rapidly, and in a week has recovered its usual brilliancy.

The restlessness of its inhabitants is the best indication that something is wrong with an aquarium, and a few sharp strokes with a syringe will probably reveal the cause. If this is removed with a glass tube stopped with the finger, the whole well agitated and syringed, it will probably right itself in a few hours, especially if it is exposed to a little stronger light than usual to aid the evolution of oxygen. It is somewhat remarkable how an aquarium which is very bad both to sight and smell will recover itself under these conditions.

With regard to the stocking of an aquarium, I can offer little in the way of suggestion as I have gone on no settled principle. Living in London one has to take things as they come, and sometimes they come just when you are least prepared for them. My own experience is that you cannot make an aquarium a happy family of all kinds of Actinia. Even those that require nearly the same conditions do not appear to thrive equally well when together, and it will frequently be found that removal to another aquarium will be followed by a great improvement. This is particularly noticeable with *Anthea*, which I have found a most difficult anemone

to keep, and which has gone the round of four or five Aquaria before it was suited. I am speaking of Aquaria holding about eight or ten gallons of water; doubtless larger ones of twenty or twenty-five gallons capacity would offer better conditions, but as the various forms of Actinia are found in various circumstances, it is possible that the presence of some may be inimical to the well-being of others, and that they would prefer their room to their company.

The varieties of *Sagartia* do very well together, but *Actinolobus dianthus* often appears very restless in the same aquarium. I have succeeded in keeping *Tealia crassicornis* for some months in perfect condition with *Anthea Cereus*, the former requiring a bed of sandy shingle with pieces of rock interspersed against which they lodge. The *Anthea* has remained on the rock without showing any disposition to roam. The quantity of anemones that may be kept depends very much upon the conditions of the aquarium. I have seen a small one holding about a gallon of water which contained eight or ten anemones, consisting of *Dianthus*, *Bunodes*, and *Mesembryanthemum*, which, when fully expanded, covered the bottom, and all thoroughly vigorous, but this was arrived at by considerable attention.

For feeding Actinia I invariably use oyster, and this food is suitable even for the very smallest. For some time I hesitated about keeping *Corynactis* on account of the supposed difficulty in feeding them, but I have since found that they are readily fed by very small pieces of oyster held to the tentacles on the point of a stick; this they take greedily if in a healthy condition, and the same holds good for Actinia smaller than these, for the younger they are the more readily do they seize the food offered them. The feeding of other animal life in Aquaria presents little difficulty, as there are few forms for which some method may not be devised. *Hydra tuba* I have fed by removing the stone on which they were fixed to a small vessel of water, reversing the usual position and smearing the Hydra with oyster made into a pulp. After an hour or so the stone is passed to and fro in the water to detach any oyster which has not been grasped and then replaced in its usual position. Where it is impossible to use oyster in feeding, condensing light by a bull's eye in the neighbourhood of an animal will attract Entomostraca, and thus give a better chance of food, while if it be desired to feed Entomostraca, Rotiferæ, and Infusoria

this may be accomplished by rubbing confervæ (marine or fresh-water as may be required) in a mortar with a little water and adding it to the vessel containing them. Fed in this way they are much more interesting when viewed microscopically, as the brilliant colour of the fresh Chlorophyll enables the alimentary canal or stomach to be readily defined; this food must be more natural than the old method of carmine or indigo.

The time of year at which we are compelled to make our Whitstable excursion is much against the successful preservation of any objects that may be found, but the methods we ourselves adopt are as little calculated as the season to conduce to their vitality. If the bottles we take were exposed some days previously, full of sea-water with a small piece of confervæ, to light and air, the vegetation which would be formed would probably afford sufficient oxygen to keep the contents in vigour for some time. As an instance of the ease with which small quantities of sea-water containing animal life may be preserved, I show you here a small bottle containing about three ounces of sea-water. This has been in the same condition as you see it for many months. It contains a minute Amæba in large quantity, and has in no way deteriorated from the first day the material was put in. I have also with me this evening an ordinary glass tumbler in which vegetation has been allowed to form. This has remained a perfect marine aquarium for many weeks, and contains several small Hydra.

From the success I have had in keeping Aquaria I am led to the conclusion that many more forms of marine life might be acclimatized in them. One of the greatest obstacles to success in keeping free swimming forms I believe to be the formation of a thin film or coating which is often very persistent on the surface of the water and which I think is most hurtful. Animals which remain permanently below the surface are little affected by it. Syringing breaks this film very readily, but it soon forms again, and not being capable of cure it has to be endured. However, notwithstanding this, the results are so encouraging for the small amount of time bestowed, that I can unhesitatingly recommend the keeping of Marine Aquaria both as a scientific study and a recreation.

On Arachnoidiscus as a New Test for High Power Objectives.

By T. F. Smith.

(*Read March 23rd,* 1888.)

For optical appliances this is the golden age of microscopy, and it may be confidently asserted that a better object-glass can be obtained to-day for five guineas than could have been bought only a dozen years ago for fifty. In view of the fact that the same opticians who were to the front as makers of objectives twelve years ago are to the front now, this may seem a bold assertion, until it is remembered that it is only ten years since the first oil-immersion was made, and not two years since the new optical glass has been in the market. Both these occurrences are epoch-making, and as an instrument of optical precision the Apochromatic oil-immersion object-glass of to-day is almost as much separated from the best work of twelve years ago as the Achromatics of, say, 1850 were from the old Non-achromatics of the early part of this century. Having come into this splendid possession, then, it only remains to know how best to use it to advantage, and I beg to-night to offer you my experiences during the last few months as a contribution to that knowledge. It will be in the memory of the Members of this Club that I have from time to time exhibited objects in this room to illustrate some papers read by me, and that, having sometimes exhibited three or four objects at once, I have had to borrow glasses, in addition to my own, to show them. It is also vividly within my own memory that when I borrowed four oil-immersion lenses, in fixed settings, for the purpose of my first paper, and tried them on the objects I knew so well, they utterly failed to show them in a satisfactory manner. It was not that I could not see the details, but the image was dull as ditchwater, and wanting in that luminosity which an oil-immersion should always display. My first feeling was one of disgust at my want of success, and a desire to throw the thing up as a failure; but a few trials convinced me that the cause of the mischief was the lenses being set at the wrong point,

and, with the help of the makers, I was enabled to have them put right, and they then performed as brilliantly as my own.

Cheap oil-immersion object-glasses, in fixed settings, are now turned out by the score, both here and on the Continent, and as it is not possible to alter the corrections except with the draw-tube, it is of the utmost importance that the lenses should be set at a point to work at their best on the vast majority of objects.

This is only reached in the oil-immersion when the object is mounted in a medium of the same refractive index as glass, and hence the mischief of setting it on a test-object, mounted dry, and supposed to be on the cover, but which is not.

Whatever may be the difference of opinion as to the structure of the Podura scale, there is no difference of opinion about the appearance of certain conventional markings on it, and that a glass which will show these markings well will work well on every other object. This may be taken for granted, and if the glass has a correction collar the observer can adjust for himself; but if there is no such means of adjustment he is reduced to do what he can with the draw-tube, which, in my experience, would require to be nine inches long to make a glass, set on the Podura scale, work well on an object mounted in balsam.

I need not say that the increase of the size of the image, and the loss of light, would make it impossible to satisfactorily adjust that way.

There are two great objections to using the Podura scale as a test object for an oil-immersion. The first is, that the conventional markings can only be seen when the scale is a little way off the cover-glass, and, consequently, the objective not working at its full aperture; and, secondly, it is impossible to tell the best point.

A dry glass, on the Podura scale, is exceedingly sensitive, and a little turn of the correction collar, or a little difference in the length of the draw-tube, will make all the difference between fine definition and no definition at all. With the oil-immersion, however, you can go through the whole range of the correction collar without making any difference in the markings, beyond changing them from red to blue. Of course, opticians will tell you that they know the best point, but my experience is as follows :—

Four object-glasses, with a correction collar, were supposed to be set with best definition on the Podura scale at the point 0; the first (my own) is best on a balsam-mounted slide at point $2\frac{1}{2}$; No.

2 glass was at its best at point 5; No. 3 at point $7\frac{1}{2}$; and the last glass at its best on the same slide at point 10, or as far as it could go. It is no use blaming opticians, for the English microscopists have been brought up (and rightly, up to a certain point) to believe in the Podura scale, and makers cannot be expected to run the risk of producing a glass that is not at its best on that test. The only way, then, is to offer a substitute that shall stand for the oil-immersion in the same relation as the Podura scale does to the dry glass, and for that purpose I beg to offer the outer plate of the *Arachnoidiscus* (anything) mounted in balsam.

To me there is a particular appropriateness in choosing this as a test object, from the fact that, although its main features for the last forty years have been as well known as the Podura scale itself, the discovery of the finer markings or structure is due entirely to the oil-immersion objective.

The first public notice and figuring of this diatom I can find occurs in a paper read by Mr. Shadbolt before the Microscopical Society on November 14th, 1849, and is found in Vol. III. of the Transactions of that Society. The plate accompanying that paper is copied into the plates in Pritchard's "Infusoria," and more recently a fine plate of the same diatom is found in Dr. Carpenter's "Microscope."* In Schmidt's "Atlas," also, are numerous drawings of this diatom, and recently Mr. Morland has described its structure to you, so that it is no stranger I am bringing before you to-night.

In all the drawings of this diatom, the markings on the side from which it takes its name are shown as oval areolation only, and this may be taken as all that has been seen up to the last two years. But in the plate accompanying the paper by Messrs. Nelson and Karop, taken as read on January 28th, 1887, the new structure is shown at Fig. 4.

The same appearance was familiar to me at the time, but I am certainly indebted to those gentlemen for a true knowledge of its character, as before that I had taken it as due to perforations in the outer membrane. I am now convinced, however, that the structure is as they say, "points projecting into the areolation from its edge." To me the advantages of this new test-object for an oil-immersion are, that the little projecting points, or spines, can only be clearly defined where the objective is perfectly correct,

* Reproduced from a drawing by the late Richard Beck, and published in his treatise on the use of the microscope.—[Ed. "J. Q. M. C."]

and set at its best point; that an oil-immersion is as sensitive on it as a dry objective is on the Podura scale, and that the best point once found and noted in this diatom, mounted in balsam, will be the best point within very narrow limits on all other objects mounted in that medium, or in any other with nearly the same refractive index.

Of course, I am pre-supposing central light, and a good wide-angled, achromatic condenser, without which conditions no wide-angled objective will work perfectly.

I do not say that every disc of this diatom will act as a test, any more than will every scale of *Podura*. Some will show no projecting species even with the widest-angled objective, and others are so coarse as to be no test at all; but a properly-selected one will answer all the purpose, both for defining and resolving power.

The one used by myself is about the $\frac{1}{110}''$ in diameter (the one under the $\frac{1}{8}''$ is only $\frac{1}{170}''$ in diameter), is divided into 26 bays, and has about 7,000 perforations, the smallest about $\frac{1}{20000}''$ in diameter, none of which has less than four points projecting inwards from the sides, and some five or six.

When I first thought of bringing forward this test I had no intention but to confine it to oil-immersion objectives, but some dry object glasses have lately come into my hands which show such an advance on what I thought possible, that I have enlarged the scope of this paper to make it include the same object as a test for all high powers.

That the capacity of a dry objective to show these projections is a great advance in definition is proved by the fact that none of the text books portray them, and it is somewhat remarkable that Mr. Morland in his paper makes no mention of them, although his observations were, I believe, made with a water-immersion.

This advance is, I believe, due entirely to the new optical glass, of which the objectives are wholly or in part composed, and which has enabled the makers to enlarge the numerical aperture almost to the limits possible with a dry glass, without increasing the aberrations. The gain is such that the new dry objectives have entirely overleaped the boundary between themselves and the oil-immersions, and have made the old water-immersion lenses obsolete.

I do not speak this without warrant, having carefully compared them with the last formula water-immersion $\frac{1}{8}''$ of Powell and Lealand, and with Gundlach's water-immersion $\frac{1}{16}''$, both glasses

belonging to me. The Powell and Lealand's $\frac{1}{8}''$ fails completely in my hands to show this test, and I can only account for it by supposing that the central part of the glass has been sacrificed to excessive angular aperture. Failing in this test, it also fails to show other objects satisfactorily with central light when the object is composed of two or three layers of structure.

The Gundlach $\frac{1}{16}''$ is a very fine lens, and having less aperture shows the new test very well, but not better than the dry $\frac{1}{8}''$ I am showing to-night. The measure on this also is its measure on all other objects.

As an example of the fine detail that can be picked up with this new dry $\frac{1}{8}''$, and also with the Apochromatic $\frac{1}{4}''$ of Zeiss of 0·95 N.A., I may say that I have seen the flagellum of *Spirillum undula* with them with central light. Now the diameter of this *Spirillum* is the $\frac{1}{20000}$ of an inch, and if I may take the proportion of the flagellum as the one-tenth, the same as given by Dr. Dallinger, as the proportion in *Bacterium termo,* the diameter would be only the $\frac{1}{200000}$ of an inch. The thickness of the *Spirillum* I have verified by measurement, but must leave the proportion of the flagellum as an open question. One thing is certain, it must be very minute. To prove the great importance of this advance in the definition of dry objectives I beg to quote the following from a letter to "Nature," by Dr. Dallinger, written about the time when the first oil-immersions were brought out:—"Even water-immersion lenses are of limited service in observations continuously conducted upon minute living organisms in fluid. The fluid under the cover is in danger every moment of being flooded by going too near the edge of the cover, thus rendering the observation void." He further says, "That the production of oil-immersion lenses should not lead the best opticians to abandon efforts for the still greater improvements of dry lenses."

With the aid of the new optical glass I claim that the improvement Dr. Dallinger asked for has been effected, and that not only in the more expensive Apochromatic lenses produced by Zeiss, but also in the ordinary student's lenses, such as the one I show to-night.

About the beauty of the image produced by the new Apochromatics there can be no doubt, corrected as they are up to the same point both for chromatic and spherical aberration.

With the old glass this was impossible; if you corrected too

much for colour, enough spherical aberration was left to seriously impair the definition for large apertures; on the other hand, to correct perfectly for spherical aberration was to leave some outstanding colour.

This was shown several years ago by Dr. Woodward, who proved that when the "beads" of *Formosum* were projected on a screen through a white corrected glass, they could not be separated. When, however, projected on a screen through a glass which showed the markings as ruby on a green ground, they were perfectly defined. There the matter rested up to the last two years, and all the best glasses of every maker were under-corrected for colour, but perfectly corrected for spherical aberration. What the new glass has done, and *all* that it has done, is to enable an optician to produce an objective that shall be without colour, except what belongs to the object, and without sacrifice of definition, and I can bear my testimony to the beauty of the image when defined under these circumstances.

Here, then, is the ideally perfect; but it is one thing to make such an object-glass, and quite another to bring it within the reach of all willing purchasers; and I am afraid that at present at least the cost and the difficulty of producing them in sufficient numbers will stand in the way of their general adoption.

Side by side, however, with this advance to optical perfection there has been progress of another kind, which, although conducted in silence, seems to me of equal importance as bringing it within the reach of the many who, although desiring perfection in optical appliances, have but limited means to acquire it. An objective can be made wholly or partially of the new glass, and, in my experience, the improvement in definition will be equal in each, the only difference being that the one will give a coloured and the other a colourless image.

It is the importance of this other work I wish to impress upon the members of this Club, and if in connection with it I am obliged to mention names, it is because I know but of one English firm which is doing this work, and feel that unless the new glass is embodied in all new objectives there is no chance of improvement in those produced at popular prices.

The $\frac{1}{8}''$ I am showing to-night is made by Messrs. Swift and Son, and they tell me that by using the new optical glass in part construction of their lenses, they have been enabled to enlarge the

apertures without increasing the aberrations, or decreasing the working distance, and without increasing the price. They do not claim that the same results could not be produced by the old glass, but only after a long working-up, and at a price which would preclude them from being sold as student's lenses.

Personally I do not believe that the same level was ever reached with the old dry glasses, and the crispness of image in the new, which is only equalled by the old water-immersions, is entirely due to the new glass.

The general lesson I wish to inculcate then is, that knowing what is possible, microscopists should not be satisfied with less than the most absolute perfection in all modern objectives, and that they are not likely to get it unless they insist upon their being made partly at least with the new glass. It is for this purpose I beg to introduce this new test, and I can promise that any glass which will work on this will do whatever else a dry glass can do.

On some Remarkable Spicules from the Oamaru Deposit.

By B. W. Priest.

(*Read April 27th,* 1888.)

Plate XIX.

I take it for granted that you are all more or less well acquainted with the famous diatomaceous deposit from Oamaru, New Zealand, with its wonderful collection of diatoms and sponge spicules.

In examining some of the cleaned material kindly sent to me by Mr. Grove from Jackson's Paddock, a place farther up the valley than that from which the original material came, I was at once struck by the remarkable size and condition of the sponge spicules. I should think examples of almost every species of silicious sponge is represented ; most of them are well preserved, but a great many show different stages of decay and peculiar states of disintegration.

When it first occurred to me to bring this communication before you, I thought that I had, to a certain extent, discovered something new, but on reading over several papers on the subject of sponge spicules I had to fall back on the old adage that there is nothing new under the sun. At the same time, wanting more information on the subject, and being of peculiar interest, I have ventured to bring it forward.

In order that you may understand what I have to say regarding the subject, I must start by telling you a little on the development of the spicules.

It appears that the sponge spicule is developed in a cell, and may be often seen in the embryo sponge, which cell becomes lineally extended in opposite directions, or begins to put forth more or less points in a radiating direction, whereby what is called the central canal of the spicule is formed ; and upon the tubular prolongations as they extend is deposited, in concentric layers, silico- or calcareo-albuminous material of which the spicule may be composed, the extremity of the tubule or central canal only becoming covered when the fundamental form of the spicule is completed. Thus you

will almost always find the presence of an axial canal remaining hollow in the silicious spicules, although in some few of the larger forms we occasionally meet with mere imperceptible lines, indications of where it had once been, while others are entirely filled in with the material with which the spicule is composed. I might just mention here that we invariably find the cavity in the calcareous spicules quite obliterated.

Now it is the axial cavity of the silicious spicule to which I wish to draw your attention, as it is that with which we have to deal. A great many of the spicules from Jackson's Paddock have the appearance of being cracked all over in the same way that one meets with in unannealed glass, which is no doubt due partly to pressure and partly to heat in the deposit, occurring as it does in a volcanic district, some sudden change of temperature acting in that way upon them. Some will be found having a pitted appearance, such as we see sometimes in old Roman glass, and others with the peculiar enlargement of the axial cavity which we meet with in the spicules found in the deposit from Port Jeremi Hayti and in some of the deep sea soundings, which latter were made the subject of a paper read before the Royal Microscopical Society in 1881 by Professor Duncan. These enlargements, forming as they do such a beautiful and regular pattern, are evidently, and now generally acknowledged to be, due to the action of some penetrating organism at some time or another, probably allied to the minute alga *Palæachlya perforans*, as in the recent spicules so acted upon a green colouring matter answering to the zoospores has been seen.

Now in the present case I have come across two spicules, one an acerate, the other a trifid, in which the enlarged axial cavities have a spiral, vermiform-looking body lying within them, and perfectly silicious, the silica being chalcedonic, and seems to have derived its silica from that of the spicule itself. Now the question to me arises whether this curious formation is due before fossilization to the penetration of a minute organism, which, as it died, was replaced by silica derived from the spicule, and thus causing the cavity in which it lies, assisted by the action of sea water, which is known to have a caustic action on dead sponges, or after deposition of the spicule and subsequent fossilization an infiltration of silica took place in the axial cavity, gradual disintegration of the spicule occurred internally, the internal structure being, I believe, more susceptible of decay than the external at first.

I can quite understand to some extent a vegetable organism penetrating a calcareous substance, but I cannot quite grasp the idea of its doing so with a silicious one, which is of such a different nature, excepting that some chemical caustic action is set up. I should be glad if any member could suggest some idea regarding the *modus operandi*. But whatever the action may be, I can only follow what Professor Duncan says at the end of his paper:—"It is evident that spicules have to obey the inevitable laws of change, death, and dissolution. The spicule which has lived has to decay, and may live again in another form; and this new one will have by-and-bye to illustrate in its turn the æsthetics of destroying nature—of that environment which develops the grand outlines of the hills as their rocks crumble away, and which condescends to beautify the tiny microcosm as it passes away and plays its little part in the scheme of evolution."

DESCRIPTION OF PLATE XIX.

Figs. 1 and 2.—Spicules showing curious formation in the enlarged axial cavities.
Fig. 3.—Spicule showing cracked appearance.
Fig. 4.—Spicule with enlarged axial cavity.
Fig. 5.—Spicule with pitted appearance over the surface.

On the Reproductive Organs, especially the Antheridia, of some of the Florideæ.

By T. H. Buffham.

Plates XX, XXI, XXII.

(*Read May 25th*, 1888.)

In February, 1884, I had the honour of reading before the Club a paper on this subject ("Journal," Vol. i, Series II, p. 337), in which I gave a sketch of the functions of the reproductive organs of this division of the Marine Algæ. In it I pointed out that besides the asexual bodies (tetraspores), and the sexual fruit (cystocarps), there are others (antheridia) which are the male organs. And whilst the last-named by their interesting forms would amply repay the student who would make a diligent search for them, at the same time—being much less known than the tetraspores and cystocarps—their discovery would advance our knowledge, for there are still many of the red sea-weeds the antheridia of which have not been recorded in Britain.

Since the date just mentioned I have attempted something in this direction as my limited opportunities permitted, and this paper furnishes further examples of those native species I have, down to last July, observed, not including any antheridia drawn or described by Harvey in "Phycologia Britannica" or collected by others (with a few exceptions which will be specified).

Although exquisite figures of the antheridia of two of the species have been given by Thuret and Bornet I have ventured to attempt others from my specimens, as the works of those algologists are not in the library of the Club. A third example is drawn because it differs somewhat from Prof. W. G. Farlow's figure, to which a more detailed reference will presently be made. Of the rest of the species drawn I am not aware that there are any figures published. They were all made from specimens preserved in glycerine or a saturated solution of chloride of sodium.

Where the present names differ from those in "Phy. Brit." the

latter are given in parentheses. Localities and dates are indicated in the same manner.

Porphyra-laciniata Ag. (*P. linearis* Grev., *P. vulgaris* Harv.) was formerly associated with *Ulva* and other green plants which are reproduced by zoöspores, and although our knowledge of its mode of reproduction is less complete than that of many others of the *Florideæ* its antheridia furnish an instructive example of the simple manner in which these bodies are sometimes developed. On a male plant one can observe the cells with their coloured contents a short distance from the free margin of the frond. The division and subdivision and gradual loss of colour can be traced until near the margin there is seen a multitude of minute spherical bodies. A section of the frond shows that the cells have also undergone a similar subdivision in directions parallel to its surfaces, so that each original cell produces 32 to 64 antherozoids. (Folkestone, July, 1886.)

In marked contrast to the foregoing is a beautiful plant, *Helminthora divaricata* J. Ag. (*Dudresnaia divaricata* J. Ag.) Pl. XX, fig. 1, represents one of the much-branched horizontal filaments which arise from the axis and form the cortex; at the apices are the antheridia, × 25. Fig. 2 shows the tips of a fragment surmounted with tufts of spherical antherozoids produced by the repeated division of the small cells, and somewhat spread out, × 400. This is a very elegant and delicate object, each antherozoid being separately seen, and but ·0025 mm. in diameter. On the first specimen observed (Sidmouth, Aug., 1884) the branches all bore cystocarps, and the antheridia were intermixed with the fruit on the principal filament. The figures however were drawn from specimens taken later (Weymouth, Aug., 1885), and these were entirely male plants, the whole of the frond glittering with the antheridia which covered its surface.

In *Callithamnion*, as in many other genera, the antheridia occupy positions on the plants similar to those of the tetraspores. Usually the species are diœcious, but *C. brachiatum* Bonnem. is monœcious. The cystocarps are very conspicuous, and the antheridia may very easily be overlooked. They are found on the younger filaments, and even in the same tufts touching the young cystocarps. Here on an internode each antheridium is a subglobose body, the surface covered with very small colourless dots. By focussing with a high power below the surface the structure is

clearly seen. At the base is a larger cell, and this divides radially, the divisions also spreading round so that the ultimate cells form the antherozoids. Fig. 3 shows this appearance under a power of 400. (Weymouth, Sept., 1882.)

Almost identical in form, structure, and position are the antheridia of *C. tetragonum* Ag., of which the preceding is held by some as but a variety. It also has the male and female organs intermixed, but in my specimen (Sidmouth, Aug., 1884) there are many tufts with numerous antheridia alone.

In *C. Hookeri* Ag. these bodies are less regularly formed, and are found in groups of four or five on the upper side of adjoining cells of the smaller branchlets. As they mature they coalesce and form a continuous layer. (A small male plant, Weymouth, Aug., 1885.)

Dudresnaya coccinea Crouan is a very beautiful plant with any power. The cystocarps are very conspicuous by their full colour amongst the paler loose tufts of delicate branched filaments which surround the axis. Here and there a filament on the same plant divides at the summit into a loose tuft bearing the minute cells which contain the antherozoids. They are similar to the antheridia of *Helminthora divaricata* (fig. 1), but much less distinguishable. (Sidmouth, Aug., 1886.)

Glœosiphonia capillaris Carm. is another interesting plant, but the branching filaments form a distinct cortex. The antheridia, also on the same plants as the cystocarps, are very indistinct, whitish, minute spots of small cells formed by division of the cortical cells. I detected these on a specimen collected by Mr. R. V. Tellam (on the Cornish Coast, July, 1887).

In my former paper (*loc. cit.*, p. 342) I referred to the circumstance that the antheridia of that ubiquitous alga *Ceramium rubrum* Ag. had not then been found on our coasts. Not long afterwards (Brighton, Sept., 1884) I took a plant of this species which bore the male organs on the small lateral ramules. They form a continuous layer of minute cells, but are so inconspicuous as to be unsuspected without microscopic examination. They occurred on a plant with long, very sparely-branched, filaments. Another form of this very variable species was afterwards taken. (Weymouth, Aug., 1885.) The structure and habit of this are very like those of *C. flabelligerum* J. Ag., but it is quite devoid of spines. The layer of antheridial cells is usually only on one half of the filaments, but the apices of all bear them.

In *C. tenuissimum* J. Ag. (*C. nodosum* Griff. et Harv.) the antheridia are much more readily seen, as the nodes are prominent, and the antheridia are seated thereon, generally on the inner sides, and rather more on the lower sides, of the nodes of the greater part of the plant. Fig. 4 shows a node with the cortical cells changing into the antheridia which form a cushion of rounded outline and composed of small yellowish cells, ×200. (Sidmouth, Aug., 1886.)

These bodies have also been observed on several other species of *Ceramium.*

C. Deslongchampsii Chauv.: a continuous brownish-white layer on the upper portions of filaments and on the lateral ramuli. (Taken by a friend at Llandudno, July, 1886.)

C. gracillimum Griff. et Harv.: delicate cushions surrounding the nodes, or on the inner half only. (Brighton, Sept., 1884.)

C. circinatum J. Ag. (not in "Phy. Brit."): at first chiefly on the inner sides, but later forming an almost continuous layer round the uppermost filaments. (Brighton, Sept., 1884. A tetrasporic plant was found at the same time.)

Spyridia filamentosa Harv. is a plant delighting in warmth, and therefore is plentiful at only a few stations on our southern shores. At Sidmouth, in sunny pools, it is so, and I determined when there (Aug., 1886) to find, if possible, the antheridia which, so far as I know, have been described only by Prof. W. G. Farlow in "Marine Algæ of New England," p. 140. I succeeded only after examining with the microscope some hundreds of specimens. At last, on a plant that had a peculiar tufted appearance, I was rewarded. The antheridia were found on the monosiphonous secondary branchlets which in the male plant frequently radiate in small dense tufts from the principal branches. They form, under a low power, a continuous greyish layer over the basal cells of the secondary branchlets, giving it a swollen appearance (fig. 5, ×25). Prof. Farlow shows (Pl. X, fig. 1) a single node surrounded with antheridia and separated from the main portion by a clear part. In my specimen there are no such instances. The younger branchlets have them covering slightly two or three joints; the development appears to be by the extension joint by joint upwards. A power of 200 shows a rather loose layer of pale cells, each containing an antherozoid (fig. 6).

Amongst other plants received from Mr. J. T. Hillier, of Rams-

gate, March, 1885, there was one of *Fastigiaria furcellata* Stackhouse (*Furcellaria fastigiata* Lamour) which had the "ovate, pale-coloured, pod-like bodies" which puzzled Harvey. These form the apices, about 8 mm. long, of the plant, and are antheridia. The whole of the surface is covered by small yellowish cells, and a transverse section of the "pod" shows them to be slightly elongated vertically to the axis of the filament.

In *Chylocladia articulata* Grev. the antheridia form a layer covering one or two of the upper internodes of a filament, almost white, the surface showing only minute pale dots without arrangement. At the edge of the filament, however, the cells are seen to be much more elongated than in the preceding species, and very much smaller. (Sidmouth, Aug., 1886.)

I picked up at Ramsgate (in June of the same year) a delicate-looking specimen of *Delesseria Hypoglossum* Lamour. The frondlets were much narrower than in the type of this very variable species. I noticed that in place of the sori of tetraspores there were two narrow white lines (Pl. XXI, fig. 7) which the microscope soon showed were antheridia. They lie along either side of the midrib and on both surfaces of the frondlet, and the edges have very irregular boundaries like coast-lines on a map. There is observable, however, a somewhat oblique linear arrangement agreeing with the set of the ordinary coloured cells (fig. 8, $\times 25$), and frequently they occur in spots and patches. On examination with a power of 400 the separate cells are distinctly seen to form a projecting surface, and on focussing down to an edge of a promontory the cells are found to be elongated, each containing, as usual, the antherozoid near its extremity (fig. 9).

Catenella Opuntia Grev., at all times curious-looking, was found (Sidmouth, Aug., 1886) having a most *bizarre* appearance. Intermixed with cystocarps of all ages were pale bodies, single or in irregular groups. Roughly spherical they are readily distinguishable from young cystocarps, which have a wide hyaline border, by their wrinkled and somewhat withered aspect, and a faint appearance of numerous lobes (fig. 10, $\times 25$). With a power of 100 the surface is seen to be covered with a large number of groups of minute colourless dots (fig. 11). It is remarkable that such an experienced collector as Mr. E. M. Holmes, F.L.S., F.R.M.S., has not met with the cystocarps of this species, and the learned French algologist, Dr. Ed. Bornet, wrote me saying: "Je connais depuis

longtemps les anthéridies, mais je n'ai *jamais vu* les cystocarpes." As Dr. Hauck observes: "Cystocarpien bei *C. Opuntia* nicht genügend bekannt"* I much regret that I did not secure more material for the better study of the fruit.

The male plant of *Gelidium latifolium* Born. (*G. corneum* Lamour, var. *G. latifolium*) shows pale, but semi-opaque, patches on swollen parts of the pinnules, which are the antheridia. The cells are oblong, and densely packed vertically. (Weymouth, Aug., 1885.)

The antheridia of *Lomentaria reflexa* Chauv. (*Chylocladia reflexa* Lenorm.) are found on swollen joints, and appear under a low power as minute greyish spots on the surface (fig. 12, × 25). With a magnification of 200 each small patch is seen to be composed of colourless bodies, somewhat radiate and convex, the patches being confluent (fig. 13). The edge of the frond viewed with 400 (fig. 14) shows that the minute filaments composing the antheridial layer are somewhat branched, the whole being covered by the hyaline gelatinous investment usual to this plant. (Sidmouth, Aug., 1886.)

The male organs of *Chondriopsis tenuissima* Ag. (*Laurencia tenuissima* Grev.) are very interesting, and are unlike those of other genera. In this species the antheridia consist of bi-convex disc-like bodies, sometimes contorted, which are borne in clusters at the apices of short lateral ramuli, the convexity being generally unequal (Pl. XXII, fig. 15). The antherozoids are elongated, and a little thinner at one end, and the disc on which they are developed is hyaline, with a border of delicate large cells having slightly darker contents. These border cells are free from the antherozoids which otherwise cover both sides of the disc (fig. 16, × 100). As the discs discharge the antherozoids the contents of the large border cells become darker. (Weymouth, Aug., 1885.)

Intermixed with tetrasporic plants received from Mr. J. T. Hillier, of Ramsgate, Feb., 1885, was a male plant of *Rhodomela subfusca* Ag. The antheridia occupy similar positions on the filaments, and consist of dense tufts of a brownish-yellow colour, readily seen by the naked eye, springing from the sides of the filaments of the plant. A short peduncle divides several times, and on these divisions the branching tufts are produced (fig. 17, × 10). Each ultimate branchlet consists of a cylindrical body of a pale-

* "Die Meeresalgen Deutschlands und Oesterrichs," p. 186.

yellowish tint, with the cells containing the antherozoids forming its surface. It tapers towards its extremity where two or three yellowish bare cells of the axis appear. The general resemblance of a branchlet to the antheridium of certain *Polysiphoniæ** will be apparent (fig. 18, × 100). I gathered the male plant at Folkestone two months later (April).

The antheridia of that very beautiful plant *Polysiphonia byssoides* Grev. are oblong-ovoid, and, being borne in tufts on the fine ramuli, are—unlike those of other species of this genus—seen all over the plant. The cells containing the antherozoids are loosely placed round the axis so that the joints of the latter can be readily seen. Amongst the antheridia were the cystocarps more or less intermixed on different branches of the plant found. (Sidmouth, Aug., 1884.) At the same time another plant with tetraspores had also antheridia amongst the asexual organs, which is a rare combination.

P. obscura Ag. is a very minute creeping plant, the antheridia of which are found in the usual position. They are tapering (not mucronate), strongly curved, the cellules densely arranged. (Sidmouth, Aug., 1886.)

Very similar are these organs in *P. fruticulosa* Spreng. (*Rytiphlœa fruticulosa* Harv.), only that they are decidedly mucronate, the axial fibre projecting in some cases to a length equal to that of the antheridium itself. (Sidmouth, Aug., 1886.)

The male organs in the foregoing genus are sometimes so obtrusive that they may be discerned by the unassisted eye, but this is not at all the case with that common plant *Dasya coccinea* Ag., and it is another instance where they have so seldom been detected by reason of their inconspicuousness. The male plant, however, does differ in habit, for the coloured monosiphonous filaments which terminate the branches form dense corymbose tufts, and of a paler tint than the barren plant. The antheridium consists of an outgrowth from all but the two or three basal and the four to six terminal cells of the monosiphonous filament, which thus becomes invested with a layer of colourless cellules. With a power of 100 these are seen to be densely placed upon the original cells of the filament, and although these cells have not the vivid rose colour of the uncovered cells, the pale pink tint is faintly perceived through

* In my former paper (*loc. cit.*, p. 343) *P. elongata* should be *P. nigrescens* Grev.

the antheridial layer, and a line of minute dots just exterior to the cells also exhibits the same tint (fig. 19). A transverse section is serviceable (fig. 20, ×200). In this the central cell wall is, of course, a circular ring. Round this radiate irregularly the colourless oblong cellules, closely adhering, and containing a flask-shaped body, the basal part of which is slightly tinted, the cellules being encircled by a denser periphery. (Weymouth, Aug., 1885. Previously discovered by Mr. E. A. Batters, F.L.S., Sept., 1882.)

In my former paper I mentioned that curious plant *Bostrychia scorpioides* Mont. (*Helicothamnion scorpioides* Kütz.), and the rarity of the tetraspores, and particularly of the cystocarps. I made a special search at the same station (near Portland, Aug., 1885), and succeeded in obtaining, besides the tetraspores, excellent specimens of the cystocarps in all stages from the procarps with trichogynes to the mature fruit. I also found the male plant. The antheridium is of some length, cylindrical, and terminal on the ordinary filaments, rather thicker than these, and pale, the cellules being evidently formed by division of the ordinary coloured cells (fig. 21, ×50).

In the well-known group of calcareous algæ, the *Corallinaceæ*, one form of reproductive bodies was known in Harvey's time, namely, the zonate tetraspores, but as these were contained in conceptacles they were believed to be the only kind. Since then the true carpospores have been discovered, as also the antheridia; and in *Corallina officinalis* Linn., and in some other species, all three kinds of organs are found in conceptacles of similar form, though differing slightly. The order has therefore been raised to the highest position in the *Florideæ*. So rare, however, are the sexual organs that Bornet found, while examining hundreds of specimens, only three bearing antheridia and one with cystocarps. After macerating some plants in dilute hydrochloric acid I observed one with male conceptacles. The base of the cavity of the conceptacle is lined with minute fibres on which the antherozoids are borne. (Brighton, June, 1885.)

In *Jania corniculata* Lamour. both male and female conceptacles are found on the same plant, the former being longer and narrower than the latter, and not corniculated. The antherozoids appear to be on shorter filaments than in the preceding species. (In a miscellaneous gathering by a non-algological friend at Falmouth, June, 1886.)

Much more difficult to detect, as a rule, are the delicate and evanescent trichogynes of the *Florideæ*, but students who desire to understand the reproductive processes will wish to see them, and I may mention that, besides those of *Callithamnion tetricum* Ag., described and figured formerly, I have observed the following, most of them with antherozoids attached :—

Spermothamnion repens (*Callithamnion repens* Lyngb.).
Sp. Turneri Aresch. (*Call. Turneri* Ag.)
Spondylothamnion multifidum Näg. (*Wrangelia multifida* J. Ag.)
Helminthora divaricata J. Ag. (*Dudresnaia divaricata* J. Ag.)
Callithamnion brachiatum Bonnem.
Dudresnaya coccinea Crouan.
Glœosiphonia capillaris Carm.
Spyridia filamentosa Harv.
Plocamium coccineum Lyngb.
Chondriopsis dasyphylla Ag. (*Laurencia dasyphylla* Grev.)
Ch. tenuissima Ag. (*L. tenuissima* Grev.)
Polysiphonia fibrata Harv.
P. affinis Moore.
P. byssoides Grev.
P. fruticulosa Spreng. (*Rytiphlœa fruticulosa* Harv.)
Bostrychia scorpioides Mont. (*Helicothamnion scorpioides* Kütz.)

In *Dudresnaya* the mode of fecundation is extremely curious and interesting : tubes go from the trichophoric apparatus to a procarp, and this in turn sends out another tube to another procarp, and so on until several are fertilized in turn. In *Spyridia* I have found two trichogynes on each of several procarps.

Mention has several times been made of instances, though unusual, where two kinds of the reproductive organs have been seen on the same plant. In *Seirospora Griffithsiana* Harv. that author describes the fruit as tetraspores "in beaded dichotomous strings." Now these bodies are not tetraspores, and are never divided, but he may, nevertheless, have seen tetraspores, for they are sometimes found, isolated, and some distance below the seirospores, the inference only (that all were tetraspores) being wrong. Such examples I took at Weymouth, Sept., 1882, and Aug., 1885. *Spyridia filamentosa* Harv. bearing both cystocarps and tetraspores was gathered at Sidmouth, Aug., 1886. On *Lomentaria kaliformis* Gaill. the same association was found at the same time and station.

It may not be out of place here to state that in two species of the last-named genus the tetraspores are further divided so that each sporangium appears to have sixteen (instead of the four usual) spores or sporules.

L. ovalis Endl. was collected by my friend, Mr. W. H. Gilburt, at Teignmouth, in Aug., 1881; *L. reflexa* Chauv. by myself at Sidmouth, Aug., 1886.

DESCRIPTION OF PLATES XX., XXI., XXII.

PLATE XX.

FIG. 1.—*Helminthora divaricata* J. Ag. Corymbose branch bearing antheridia, × 25.

,, 2.—Tip of the same showing antherozoids, × 400.

,, 3.—*Callithamnion brachiatum* Bonnem. Optical section of an antheridium, × 400.

,, 4.—*Ceramium tenuissimum* J. Ag. An antheridium on inner side of node, × 200.

,, 5.—*Spyridia filamentosa* Harv. Two secondary branchlets bearing antheridia, × 25.

,, 6.—Ditto. Antheridium, × 200.

PLATE XXI.

,, 7.—*Delesseria Hypoglossum* Lamour. Part of plant with antheridia. n. s.

,, 8.—Ditto. Portion of a frondlet. Antheridia in lines, × 25.

,, 9.—Ditto. Edge of a promontory of the same projecting on to the coloured surface of frond, × 400.

,, 10.—*Catenella Opuntia* Grev. Small portion of frond with groups of antheridia, × 25.

,, 11.—Ditto. An antheridium, × 100.

,, 12.—*Lomentaria reflexa* Chauv. Filament bearing antheridia, × 25.

,, 13.—Ditto. Surface of antheridia, × 200.

,, 14.—Ditto. Profile of antheridial layer, × 400.

PLATE XXII.

,, 15.—*Chondriopsis tenuissima* Ag. A ramule bearing a group of antheridia, × 25.

,, 16.—Ditto. Side view of antheridium, × 100.

,, 17.—*Rhodomela subfusca*, Ag. Tuft of antheridia, × 10.

,, 18.—Ditto. Terminal portion of antheridium, × 100.

,, 19.—*Dasya coccinea* Ag. Monosiphonous filament invested with an antheridium, × 100.

,, 20.—Ditto. Transverse section of antheridium, × 200.

,, 21.—*Bostrychia scorpioides* Mont. Apex of filament developed into an antheridium, × 50.

On True versus False Images in Microscopy.

By T. F. Smith.

(*Read May 25th*, 1888.)

The object of my paper to-night is to endeavour to help clear away the doubt about what may be accepted as a true interpretation of microscopic structure. To myself the subject presents no difficulty whatever, believing, as I do, that with proper illumination the image may be absolutely depended upon; but I cannot, in the face of all that has been written to the contrary, and especially in reference to the extraordinary paper in the last February number of the "Journal of the Royal Microscopical Society" on "Histological Structure and the Diffraction Theory," be blind to the fact that the minds of many microscopists are in a state of chaos as to what they may accept and what reject of the image presented to the eye. I admit it requires a certain amount of courage to believe the evidence of one's own eyes, when so eminent an authority as Dr. Abbé tells us it is impossible the microscope can give a correct image under the circumstances; but great as may be mathematics, great also is common sense, and, as far as I am concerned, when the image I look at tells me it is the only possible interpretation of the structure, I am bound to believe it.

In the October and November numbers of the "Monthly Microscopical Journal" for 1875, appear some extracts from Mr. Fripp's translation of Dr. Abbé's "Paper on the Microscope," which translation gave for the first time in English an account of the celebrated "Diffraction Theory." In it Dr. Abbé teaches that while the parts of an object not exceeding in size the $\frac{1}{2500}$ part of an inch are imaged geometrically, and consequently an exact counterpart of the object, the delineation of the finer structure is due to the diffraction of light, and is, as a rule, not imaged conformably with the actual constituent detail of the object itself. In giving examples, he says that it is impossible to determine the structure of the finer kinds of diatoms from their microscopical appearance. "Whether, for instance, *Pleurasigma angulatum*

possesses two or three sets of striæ; whether striation exists at all; whether the visible delineation is caused by isolated prominences or depressions, &c., no microscope, however perfect, no amplification, however magnified, can inform us." Then further on he states: "That the same state of things obtains in numerous instances of organic forms, the study of which belongs to the province of histology, we may learn from the instance of striated muscular fibre. The manifold changes in the character of the images which present themselves, account, to a certain extent, for the notorious discordance between the different observers, and prove also the impossibility of acquiring any definite knowledge of their actual physical structure."

I think you will admit that this is not a mere sprinkling, but a regular deluge of doubt with which to quench the ardour of the investigator intent on forcing Nature to give up her secrets, and even Dr. Abbé seems to be frightened at the logical outcome of his own theory, for further on he says: "It is obvious that a perfect fusion, in every case of the several diffraction images, and then an exact superposition of the resultant diffraction image upon the absorption image, is only possible when the objective is uniformly free from aberration over the whole area of its aperture." This clearly means that given perfect correction of the objective there is perfect definition of the object, which to me seems to contradict the former part of the paper. I trace in all Dr. Abbé's subsequent papers the influence of two moods, and that at times he could not resist the evidence, as the aperture of the objectives became larger, that the image given by them was a truthful one. As formulated by him in his paper on the "Estimation of Aperture of the Microscope," the Diffraction Theory stands thus: "*Perfect similarity* between the microscopical image and the object, or the enlarged projection of the object by the microscope, *always* depends on the admission to, and utilization by the objective, of the whole of the diffracted rays which the structure is competent to emit. When a portion only of the total diffraction fan appertaining to a given structure is *lost*, the image is more or less *incomplete or dissimilar*. When a portion only of the whole diffracted light from a structure is utilized, the image is a true enlarged projection of a *different structure*,* namely, one of the *whole of whose diffracted beams* would, if it physically existed, be represented by

* These italics are mine.—T. F. S.

the utilized diffraction beams of the structure in question." As I understand Dr. Abbé, it means simply this: The image given under the microscope may be a true enlarged image of the object, or it may be the image of something totally different, and nowhere does he give us a rule by which to distinguish the true from the false; so that, in spite of the increase of light in our objectives, we are left in worse than "Egyptian Darkness" for the want of a clear ray to guide us to a right interpretation of structure.

It must be remembered that the first paper appeared in 1875, at a time when microscopists were running after false methods of illumination, and setting up diverse images of structure, produced by throwing the light on the object from every direction except the right one; and I can understand an authoritative voice declaring that the totally different results were due to the nature of light itself, and not to bad manipulation, coming as a relief to many minds weary of trying to formulate a system out of such discordant elements. But since then has come the oil-immersion objective and the oil-immersion condenser, throwing a flood of light on the image not possible under the old methods; and what I cannot understand is that people should now revive the old doubts.

What I claim to-night is "Free Thought" for microscopy, and not dogma; and I wish for a short time, by the aid of private judgment only, to see how the development of the same structures under different apertures agrees with Dr. Abbé's "Diffraction Theory." Let us begin, then, with our old friend *Angulatum*, so frequently trotted out as a "shocking example" of depraved exhibition of false structure, and see how far his appearance agrees with this character.

As *Pleurosigma angulatum* can be resolved into dots with a $\frac{4}{10}$ths in. of ·64 N.A., there is plenty of space in which to watch what changes take place in the structure between that and the increase to 1·40 N.A., as provided by the new Apochromatic oil-immersion. As a matter of fact, with the same illumination—convergent light from a wide angled condenser—there is no change whatever beyond increased sharpness of the image, which to me proves one of two things. Either the whole of the diffraction spectra have been taken up by the smaller aperture, or the similarity of the image to the object does not depend upon all the spectra being utilized by the objective. Of course, I am aware

that other appearances have been figured in this diatom, but as they depend upon certain pencils of light being stopped out from the back of the objective, I cannot regard this as a serious attempt at elucidation of structure, and would as soon believe that an actor's face could not be known to his friends because it assumes different appearances under the limelight, as to believe that the structure of *Angulatum* cannot be known because it is different when certain of the diffracted rays are shut off.

We come now to striated muscular fibre, of which I have brought two examples here to-night, and have placed one under a $\frac{1}{8}$in. and the other under Zeiss' Apochromatic $\frac{1}{4}$in. for your inspection; and I beg to say that it is with the optical appearances only, and not the physiological properties I have to deal. Like the "rustic," who, when asked if he understood the sermon, replied, "Would I hae the presumption," it is not for me, in the presence of so many medical gentlemen, to talk about structure, for the estimation of which I have received no special training, but I am concerned with the truth or falsehood of the *appearance* of the structure, as it affects all microscopic vision. When two specimens of the same tissue, subjected to the same conditions of illumination, quality, and aperture of the objectives, differ in their optical appearance, it is obvious that change of structure, and not the effect of light, accounts for the difference. The specimens are both teased-out muscular fibre of pig, both from the same mounter, and have been (I presume) treated in the same manner. The one under the $\frac{1}{8}$in. has the ordinary light and dark bands, with Krause's membrane in the middle of the light; the one under the Apochromatic $\frac{1}{4}$in. is divided into equally placed discs, of which it is impossible to tell which is Krause's membrane. Here also again there is no difference of structure delineated by the objective of the least aperture that will show it and the widest angled oil-immersion, and there is the same characteristic divergence in both specimens. I have examined them with a $\frac{1}{2}$in. of ·50 N.A. and an oil-immersion of 1·40, and beyond the difference between them of faintness and sharpness of image there is no new development of detail. Between the two extremes shown here there are more or less indications in other specimens of imperfect cleavage transversely, and it is on these diverse appearances that have been built up Hensen's membrane, accessory discs, and all the other elaborate structure which never had any differentiated existence except in the imagina-

tions of their discoverers. There is discordance enough, and Dr. Abbé can only reconcile the differences by declaring that owing to the nature of light itself no true knowledge of such structure is possible. But is it not possible that something a little less potent than the laws of light may be at fault, and lie sometimes with the observers themselves ; that it may be possible to try to evolve a type of structure out of the little bit of muscle under one's nose without taking the precaution to see if under different conditions the same substance may not assume different appearances ? The cause of the difference of the appearance of muscular fibre I take to be very simple, and to lie in its tendency to split into very minute fibrils longitudinally, and into minute discs transversely, and the displacement of the different parts under this process will account for all the appearances, whether of beaded structure or discs. Some of the fibrils are very minute indeed. I have measured some not more than the $\frac{1}{50000}$ of an inch in thickness. Now imagine a bundle split up thus, and dividing at the same time into minute discs transversely, and you must have the appearance of a structure all beads. The single fibril under the Apochromatic is bent round on itself; at the bend two of the discs converge towards each other at the inner circumference, leaving a wedge-shaped space between them. Assuming the discs to be a denser material embedded in a soft medium, this is just what would happen, and should be enough of itself to prove the appearance truthful. Mr. Nelson claims to have discovered eight discs in the space where I show six. To reject his evidence on that particular bit of muscle would, I think, be unscientific, for surely if a dark band can split into two small, there is no reason in itself why it should not split into three smaller discs.

To recur to *Pleurosigma angulatum*. I will admit that there is no particular reason why it presents the ordinary appearance, that there is no connection here between structure and function. Considered as a silicious envelope for the vegetable cell, the pattern might be arranged in twenty different ways without being less suited to the purpose for which it was constructed. We may have a reasonable belief that the appearance is truthful, but it does not come home with that absolute conviction as some other structures, which must be what they appear if the same natural laws of force and resistance apply in microscopic structure as in the larger world. Take the scales of butterflies and moths, for

instance. You have here two membranes, in one of which is imbedded longitudinal ribs connected with cross bars, from which spring minute rod-like bodies to support and connect the other membrane. Now, I cannot imagine a greater adaptability of means to end, combining as it does the maximum of strength with the minimum of weight, and is such a structure that any microscopist who has worked it out and knows anything about construction must feel to be absolutely truthful. The cross bars of some of the scales of the *Amathusia* are not more than the $\frac{1}{15000}$ of an inch apart, and the rod-like bodies or "villi" are visibly projecting from them. Between the coarseness of this scale and those of *Hipparchia Janira*, the cross ribs of which are not less than the $\frac{1}{100000}$ of an inch apart, lies every gradation of fineness in the scales of different species. I presume it is conceded that cross bars the $\frac{1}{15000}$ of an inch apart is within the grasp of an oil-immersion objective; but will anyone tell me in cold blood that when I see the same cross bars the $\frac{1}{100000}$ of an inch apart on a scale presenting the same main features, that they do not exist?

I have a very interesting specimen of a torn scale of the *Morpho Menelaus* under a $\frac{1}{12}$ in. oil-immersion. It is one of the scales which reflects the intense blue light under a low power, and which are, as a rule, all more or less damaged. This scale differs from most in the fact that the longitudinal ribs are broad bands, and the interspaces between them are very narrow, the reason being, I presume, to present a large surface from which to reflect the light. These bands are connected together with very slender cross bars about the $\frac{1}{80000}$ of an inch apart. Now under the pressure of mounting these bands get torn from each other and twisted about in all directions, and from each edge projects the ends of the torn strands. In the specimen under the microscope part of the smooth membrane is torn away, and the bands under are left projecting; some still fastened together by the cross bars, and some torn asunder, but showing the ragged edges where torn. There can be no question here about the image being truthful, unless we are prepared to part with our power of judging cause and effect. In conclusion, given an object-glass capable of showing a correct image of cross bars the $\frac{1}{80000}$ of an inch apart on butterfly scales, what is to prevent it from showing discs in voluntary muscle the $\frac{1}{50000}$ of an inch apart, Mr. Nelson's of the $\frac{1}{88000}$ in., or any other structure with the same fineness of detail?

On the Interpretation of a Photo-micrographic Phenomenon by the Abbé Diffraction Theory.

By E. M. Nelson.

(*Read May 25th*, 1888.)

Most photo-micrographers have observed that what in photographic language may be termed the high lights in a diatom, print darker in the negative than the ground or field. This is especially remarkable when my method of obtaining a critical image is employed, viz., that of viewing the object in the image of the source of light formed by a substage condenser.

One would be much astonished if on interposing a medium, however thin, between one's self and a source of light (*e.g.*, a piece of glass before a white cloud) the light appeared brighter through the medium than without it; for we cannot conceive of any medium that would not stop *some* light. With the microscope, however, such is not the case. When a diatom, for instance, is placed in an image of the source of light, the clear parts or interspaces of the diatom are brighter than the field. I first noticed this on my attempts to get density of background without over-exposure of image. And since, when employed in ordinary microscope work, I have particularly noted the relative brightness of field and interspace, and have found that the image received by the eye exactly corresponds with the picture impressed on the plate, viz., the high lights in the diatom are brighter than the field.

It must be remarked that a very slight difference in visual intensity when looking through the microscope will be sufficient to cause a marked contrast on the photographic plate.

It is probable that no one would have observed this small difference in visual intensity unless they were specially looking for it.

The question naturally arises, How is it caused? and I think that an answer will be found in a careful study of the diffraction theory.

Let us in the first instance take a diatom, and view it by central

light from a condenser, for example the *P. angulatum*.* When a suitable diaphragm is placed at the back of the condenser we get the dioptric beam surrounded by the six well known spectra. Now we know that if we place at the back of the objective a stop cutting off the six spectra, on looking at the image we shall see a *P. angulatum* without markings on a bright field. Suppose, now, that we photograph this and print a lantern positive. Next let us stop out the central dioptric beam and admit the six spectra. We shall now have an image of the *P. angulatum* resolved on a dark ground. Let this be photographed and a lantern slide made from the negative.

If we were to place each slide in a lantern and superimpose the images on the screen, we should find that the high lights in the diatom would be brighter than the field, because they have received strength from the second image which the field has not. This is, I believe, the true explanation of this very curious phenomenon. Whilst on this subject let me remark that I believe it to be a physical impossibility to obtain a black background in a negative of the critical image of a diatom. My experience is that the more critical the image the less the contrast. So long as you are content with a lot of white beads obtained by stopping down your condenser, putting it out of focus, or other means, it is comparatively easy to get a considerable amount of contrast. But the moment you seek a really critical image, and put your objective on its mettle by enlarging your central illuminating cone, so soon do you lose contrast.

Further, I am strongly of opinion that a print, to be of any scientific value, must be taken from an untouched-up negative. Intensification is also to be deprecated because it gives a false contrast, such as is not to be obtained when viewing the object through the microscope in the ordinary way. In brief, a photo-micrograph should be an exact representation of an object as we see it, and not a picture of our imagination. Some have brought forward photo-micrographs as evidence that their particular view of an object must be the correct one. This does not at all follow, as one can obtain in a photo-micrograph as great a variety of appearances as can be seen by the eye through the eye-piece.

* This, while suitable for an example because its six spectra are generally known, does not exhibit the phenomenon as strongly as some other diatoms.

PROCEEDINGS.

February 10th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Rotifer, *Rhinops vitrea*	Mr. F. W. Andrew.
Photo-micrographs	Mr. C. Lees Curties.
Section, bud of daisy, *Bellis perennis* ...	Mr. H. E. Freeman.
Monanthia cardui (thistle bug)	Mr. G. E. Mainland.
Navicula sparsi-punctata	Mr. H. Morland.
Xanthidium	Mr. E. M. Nelson.
Scale of *Lepisma saccharina*	Mr. T. F. Smith.
Long. section of cat's tongue	Mr. J. J. Vezey.

Attendance—Members, 39 ; Visitors, 4.

February 24th, 1888.—Twenty-Second Annual Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. R. La Thangue, Mr. George J. Gill, Mr. Gilbert John Bolden, Mr. W. W. Fletcher, Mr. H. V. Tebbs, Mr. J. J. Telfer, and Mr. William W. Taylor.

The following donations were announced :—

"Proceedings of the Academy of Natural Sciences of Philadelphia," 8 vols. ...	From the Academy.
"Scientific Enquirer"	,,
"Annals of Natural History"	Purchased.
"The American Naturalist"	In exchange.
"Proceedings of the Royal Society," Nos. 261-2	,,
"American Monthly Microscopical Journal" ...	,,
"Science Gossip"	From the Publishers.
"The Botanical Gazette"	In exchange.
"Bulletin of the Belgian Microscopical Society"	,,
Twelve Slides—Mineralogical Sections ...	From Mr. Hampton.

The thanks of the Club were voted to the donors.

The President announced that arrangements had been made for holding a special Exhibition meeting or Conversazione on Friday, March 9th, particulars of which were given in the circulars which had been sent out to the members. It was there intimated that each member would be entitled to introduce a friend ; and, in answer to inquiries, he stated that although

ladies were not specially invited, they would be admitted as visitors if so introduced by members.

Mr. E. M. Nelson exhibited and described a new mechanical stage of improved construction, removable at pleasure from the plain flat stage plate, to which it was simply attached by three screws.

The business of the Annual Meeting was then proceeded with.

The President appointed Mr. Mainland and Mr. T. F. Smith to act as scrutineers, and the ballot for Officers and Committee was then proceeded with.

The Secretary read the 22nd Annual Report of the Committee, also the Treasurer's Annual Statement of Accounts, which had been duly audited and found correct by the auditors appointed at the preceding meeting.

Mr. H. Epps moved "That the reports as read be adopted, and that they be printed and circulated in the usual way." He was sure all would feel that the affairs of the Club had been carried out under good guidance and management, and that the meetings had been up to the average of former years. He was struck with the request to members to do more in future, and hoped they would give this portion of the report their attention, as it was clear that the Committee saw there was room for more to be done. As regarded the excursions, they were told that "nothing extraordinary had occurred," and whilst they could not always expect that extraordinary things would occur, perhaps it would be possible to let the members know a little more of the ordinary results of the excursions. He thought also that more contributions might be made to the Journal, and that it was worth considering whether matter might not be obtained from other sources, especially as a dearth of papers was usually found during the summer season. On the whole, he thought the members might congratulate themselves upon the progress which had been reported.

Mr. Goodwin seconded the adoption of the reports, and in doing so said he should like to make one or two suggestions. He thought perhaps some of the members might have seen the report of the Manchester Microscopical Society ; if so, they would have noticed the practice of holding a meeting upon a given subject, for which purpose material was given out to the members to work upon, and it was found that very good microscopic work could be done in that way by a number of persons working together upon the same subject and combining the results of their observations. He had hinted that something of the kind might be done by the members of the Club, but was told that when tried it did not meet with much success. He would, therefore, propose that two or three members should work upon the same subject, or that each should select a particular subject, and all three work upon each, afterwards comparing notes at their meetings. If the idea was taken up, he should be very glad to combine with any other members in the matter.

The President having put the motion, declared it carried unanimously.

Mr. H. E. Freeman said, as an old member, he took it to be the function of the Club now, as formerly, not so much to try to keep abreast with science, as to encourage its pursuit amongst those who were not so

advanced. He was very glad, therefore, to hear that there was to be another exhibition meeting held, and that ladies would be admitted upon that occasion. With a view to making the gossip nights more interesting, he thought they might select some special subject—say that of some vegetable structure—and each member could then bring some particular specimen in illustration of it. On the question of the Journal, he thought that, from want of papers at the meetings, it had been for a long time kept in a kind of strait-jacket, and it was worth inquiring whether it could not be improved in some way so as to make it more interesting to outsiders.

Mr. Thos. Curties said that, in accordance with notice given at the previous meeting, he rose to move the following alteration in Rule I.: "That the words 'except July and August' be inserted after the words 'in every month,' making the rule read as follows: 'That the Quekett Microscopical Club hold its meetings at University College, Gower Street, on the fourth Friday evening in every month, except July and August, at 8 o'clock precisely, or at such other time or place as the Committee may appoint.'" This motion met with the approval of the executive, and had for its object the relief of the officers from the labours of holding meetings in the summer months, when so many members were away from home, and it was so difficult to provide subjects.

Mr. Goodwin inquired if it was proposed by this alteration to abolish two meetings altogether, or to make them conversational meetings instead of ordinary?

Mr. Curties said that the conversational meetings were not referred to at all in the bye-laws; arrangements as to them were left to the decision of the Committee.

Mr. Ingpen thought this resolution would commend itself to all the members of the Club. It was one which had come before the Committee in former years, at a time when he could not have spoken on the matter; he was, however, free to speak plainly now. He was certainly not one who was revolutionary in his tendencies, but he thought the laws of the Club need not be like those of the Medes and Persians, and did not imagine that their little world was coming to an end because they had altered the date of their annual meeting, or were proposing to drop two meetings at a time of year when it was difficult to get either critical audiences or papers to read before them. The more important question was whether they should be entirely given up or should be turned into conversational meetings. For his own part he hoped they would be retained, because he knew that it was quite possible to get up very pleasant conversational meetings during those months, although it was not easy to sustain general meetings. The relief to the Committee would, he knew, be considerable, and he was only sorry for two of their officers, the Librarian and the Curator, whose attendance would still be necessary, and wished they could contrive somehow to double their parts on those occasions.

The President wished to say that the intention of the Committee was to hold conversational meetings on the two evenings in question; but as the

wished to consult both the convenience and the pleasure of the members in the matter, he proposed to put the question formally to the meeting.

The proposal of Mr. Curties relative to the alteration in the bye-law was then put to the meeting, and carried with one dissentient.

It was then also put to the meeting by the President—"Shall there be conversational meetings on each of the fourth Fridays in the months of July and August?"—Carried unanimously in the affirmative.

The President announced that the whole of the members who had been nominated as Officers and Committee for the ensuing year, as per ballot lists, were duly elected.

The President then read his annual address.

Mr. Jas. Spencer moved "That the best thanks of the Club be given to the President for his address, and that he be requested to allow it to be printed in the Journal in the usual way."

The motion having been duly seconded was put to the meeting by the Secretary, and carried unanimously.

The following motions were also put to the meeting *seriatim*, and unanimously carried:—

"That the thanks of the Club be given to the Auditors and Scrutineers for their services," moved by Mr. Beaulah, seconded by Mr. Parsons.

"That the thanks of the Club be given to the President, Officers, and Committee for their services during the past year," moved by Mr. T. Curties, seconded by Mr. Willson.

"That the thanks of the Club be given to the Council of University College for their continued permission to meet in that building," moved by Mr. Vezey, seconded by the Secretary.

The President said he could not leave the chair without thanking the members for the vote of thanks which they had passed, as well as for the considerate kindness which he had always received during his term of office. He could only say that the duties which had fallen to him to perform had always been a source of great pleasure on account of the great kindness shown towards him by his fellow members of the Club.

The proceedings then terminated with the usual conversazione, and the following objects were exhibited:—

Stentor polymorphus	Mr. F. W. Andrew.
Parasite of Shrew	Mr. J. Beaulah.
Thistle Bug, *Monanthia cardui*	Mr. F. Enock
Section of Catkin of Yew, *Taxus bacculatus*, with pollen *in situ*	Mr. H. E. Freeman.
Oribatidæ, *Notaspis lacustris*	Mr. G. E. Mainland.

Attendance—Members, 57; Visitors, 7

March 9th, 1888.—Special Exhibition Meeting.

By permission of the Council of the College, a special exhibition of objects was held in the Library, which was attended by about 200 Members and 150 Visitors, a large number of the visitors being ladies.

The following is a list of the objects exhibited :—

Œcistus crystallinus	Mr. F. W. Andrew.
Section, tooth of *Icthyosauros*	Mr. J. W. Bailey.
„ bone of *Dinornis*	„ „
„ „ Irish elk	„ „
Eggs of butterflies, &c.	Messrs. R. and J. Beck.
Diatoms, *Pleurosigma angulatum* ...	„ „
Leaf of *Eleagnus*	„ „
Dental apparatus of starfish	Mr. F. G. Bernau.
Cylindrical epithelioma of liver	„ „
Australian sea-weed	Mr. W. A. Bevington.
Gizzard of cricket	Mr. E. T. Browne.
Section, root of *Ruscus androgymus*	Mr. W. J. Brown.
Draparnaldia glomerata	Mr. W. Chapman.
Larva of *Corethra plumicornis*	„ „
Ovary of *Begonia*	Mr. A. C. Cole.
Budding stem of citron	„ „
Reproductive organs of *Cypripedium*... ...	„ „
Triceratia from Oamaru dept.	„ „
Australian coralline	Mr. A. L. Corbett
Sole skin	„ „
Section of eyes of *Lycosa* (wolf spider), × 125, showing lens, cells, rods, and nerve fibres...	Mr. C. Lees Curties.
Photo-micrograph of same	„ „
Parasite of seal	Mr. T. Curties.
Spongilla fluviatilis	Mr. E. Dadswell.
Living *Tiresias serra*	Mr. A. Dean.
Image seen through the eye of *Dytiscus* ...	„ „
Platino-cyanide of magnesium	Mr. C. H. Drake.
Fossil shells from Barbadoes	„ „
Radiolaria, &c., from "Challenger" expedition	Mr. C. Dunning.
Mymar pulchellus	Mr. F. Enock.
Head of *Ocypus olens*	„ „
Spinnerets of *Epeira diadema*	„ „
Section of *Epeira diadema*	„ „
Insect drawings	„ „
Aspergillus glaucus, on cacao bean	Mr. H. Epps.
Catkin of yew and fertile flower	Mr. H. E. Freeman.
Sections of spiders	„ „
„ „ insects' eyes	„ „
Lower jaw of watchman beetle	Mr. F. Fitch.
Oak gall fly	Mr. W. Goodwin.
Section of cocoanut shell	„ „
Scales of sole	„ „
Foraminifera, *Haliphysema Tumanowiczii* ...	Mr. H. F. Hailes.

Head of jumping spider	Mr. W. Hainworth.
Peristome of *Funaria hygrometrica*	,, ,,
Micro-photographs	Mr. J. D. Hardy.
Parasite of turkey	Mr. F. D. Hembry.
Section of eyes of butterfly	,, ,,
Living diatoms, &c.	Mr. G. Hind.
Tail of *Mysis*, showing auditory sacs and otoliths...	Mr. W. Hughes.
Cyclosis in Vallisneria	Mr. J. E. Ingpen.
Hydra	Mr. E. K. Jacques.
Circulation of blood	,, ,,
Septum nasi, from donkey	Mr G. C. Karop.
Brachionis pala	Mr. J. J. Kern.
Œcistes crystallinus	,, ,,
Retina, human	Mr. F. J. Kitsell.
Polycistina	,, ,,
Wing of *Urania Fernandina*	Mr. J. McIntyre.
Eyes and palpæ of spider, *Pholcus phalangoides* ♂	Mr. G. E. Mainland.
Sabella	Mr. A. D. Michael.
Antennæ and grasping organs of small marine crustaceæ	,, ,,
Chlorite in quartz	Mr. H. Morland.
Amphipleura pellucida, and photo-micrographs of the same	Mr. E. M. Nelson.
Itch parasite from horse	Mr. C. H. Oakden.
Glyciphagus plumiger	,, ,,
Section of human tongue	Mr. H. W. Parritt.
Young crabs	,, ,,
Hydroid polyp, from R. Bot. Soc. Gardens	Mr. F. A. Parsons.
Tubularian, *Catenula*	Mr. T. Plowman.
Corethra plumicornis	,, ,,
Circulation in *Vallisneria*, with 1-16 imm. and patent binocular	Messrs. Powell and Lealand.
Chrysaora, medusa from *Hydra tuba*	Mr. B. W. Priest.
Plant bug, from Ceylon...	Mr. G. E. Quick.
Head of wasp, *Vespa vulgaris*	,, ,,
Campylodiscus spiralis, &c.	Mr. P. Ransom.
Cladophora, with diatoms *in situ*	Mr. F. Reeve.
Fern spores	,, ,,
Statoblast of *Lophopus*	Mr. W. W. Reeves.
Meridion circulare	Mr. J. Robinson.
Philodina citrina	Mr. C. Rousselet.
Cyclops	Mr. J. Russell.
Chalcedony	,, ,,
,, polarized	,, ,,
Spinnerets of spider	Mr. J. Scott.

Young oysters	Mr. J. Scott.
Proboscis of humming bird moth	Mr. J. E. Simmonds.
Hooklets of *Cysticercus cellulosæ*	Mr. W. Smart.
Sarcoptes scabei...	" "
Section of *Propylite*, from Hungary	Mr. Geo. Smith.
Micro-pegmatite, from an old war ship sunk at Plymouth	" "
Flint from the Purbeck, with valves of *Cypris*, from Swanage	" "
Arachnoidiscus ornatus, with Zeiss' ¼ apochromatic O.G.	Mr. T. F. Smith.
Triceratium favus " " " ...	" "
Coscinodiscus asteromphalus " ...	" "
Scale of *Pieris brassica*	" "
Elytron of diamond beetle	Mr. J. Stocken.
Toe of mouse	Mr. W. W. Taylor.
Polycistina	" "
Eggs of British butterflies and moths... ...	Mr. J. J. Vezey.
Large intestine of toad, injected	" "
Hydra Tuba, Chrysaora	Mr. H. J. Waddington.
Photo-micrographs	Mr. T. C. White.
Type slide, Foraminifera	Mr. W. Watson.
Eggs of butterflies, &c.	" "
Type slide of Oamaru diatoms...	" "
Fertile spike of *Chara*	" "
Group of diatoms	" "
Acarus of house-fly	" "
Diatoms from Mergui archipelago	Mr. J. West.
Hydroid polyp, from Kew Gardens	Mr. G. Western.
Small intestine of cat	Mr. W. D. Wickes.
Spinal cord, showing exit of motor nerve ...	" "

March 23rd, 1888.—Ordinary Meeting.

Prof. B. T. Lowne, F.R.C.S., F.L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected Members of the Club:—The Rev. J. A. Beet, Mr. Morris Simmonds, and Mr. P. Cockram.

The following donations to the Club were announced:—

"Fauna and Flora within living animals," Leidy	From Mr. Frank Crisp.
"The Microscope," Clarke	
"The Microscope and its revelations," Ferguson	
"Handbook of the Microscopes," Notcutt	

"Tentamen Hydrophytologiæ Danicæ," 2 Vols., Lyngbye	From Mr. Frank Crisp.
"Beiträge zur Naturgeschichte der Daphnidien," Weissman	"
"Naturgeschichte der Infusionsthiere," Kutorga	"
"Die Frei lebenden Capepoden," Claus ...	"
"Phenomenes sexuels des Infusories," Balbiani	"
"Infusories," Dujardin	"
"Science Gossip"	The Publisher.
"The Scientific Enquirer"	In exchange.
"Proceedings of the Royal Society," No. 263 ...	"
"19th Annual Report of the Liverpool Microscopical Society"	"
"British Oribatidæ," Vol. ii, A. D. Michael, Ray Society	Subscribed for.
"Proceedings of the Geologists' Association" ...	In exchange.
"Proceedings of the Belgian Microscopical Society"	"
"The American Monthly Microscopical Journal"	"
"The Botanical Gazette"	"
"The Essex Naturalist"	"
"Proceedings of the Natural History Society of Kieff"	"

A special vote of thanks was passed to Mr. Crisp for his valuable donation.

Mr. H. E. Freeman exhibited a small gauge in use for measuring the width of ribbon, which he thought might be useful for some purposes, as it gave the measurements in English and French equivalents.

The President said he must take that opportunity of thanking the Members of the Club for electing him as their President. When he used to come there as a Member some years ago he had no idea that it would one day be his good fortune to sit in the chair. He could only say that he esteemed it an honour, and that he would do his very best to assist the Club in any way that in him lay.

Mr. Waddington read his paper on "Marine Aquaria."

Mr. Karop inquired whether it would be possible to maintain an aquarium of this kind if sea-water could not be obtained to replenish it with—would it be dangerous to add fresh-water in order to supply loss by evaporation, and if not, would it not be necessary to take some precautions in adding fresh-water to salt?

Mr. Hardy said he had found no difficulty in keeping up the proper density by adding pond-water. This seemed to be advantageous, because there were some kinds of entomostraca which lived long enough in the salt-water to afford food for the marine inhabitants.

Mr. Goodwin thought Mr. Waddington had not done justice to himself in his paper, as anyone would say who had seen his aquaria, and he should certainly recommend any person to do this who was interested in the subject and desired to start one for himself. A great deal of disappointment

resulted from persons not understanding just the conditions which were necessary to ensure success.

Mr. T. C. White said that as an old keeper of a marine aquarium he had to thank Mr. Waddington for bringing this subject forward. He had himself read a paper on the same subject before the Club some years ago, and had seen no reasons since for altering the opinions he then stated. He kept up his aquarium for 17 years, and did not change the water once during that period. He could strongly recommend anyone to set up one for himself, and if it was kept in good condition a number of creatures would be born in it which would afford an endless variety of interesting studies. If it was possible to obtain them it was an excellent plan to obtain some old oyster shells such as were dredged up from a considerable depth and had a number of holes in them ; these perforations were excellent traps for organisms of various kinds which would in a short time develop and add greatly to the interest of the aquarium. With regard to diluting the water, this was a very important point and required great care. He used to supply the loss from evaporation by pouring in cold boiled water, for fear of adding too much lime ; distilled water was, of course, the proper thing, but he found that cold boiled water answered the purpose very well. It should be poured in very gently to prevent disturbance and to avoid altering the specific gravity too suddenly. He found it a good plan to take out about a quarter of the water so as to dilute the fresh water before adding it to the aquarium. The scum which formed on the surface might be easily removed with a strip of blotting paper. He quite agreed with Mr. Waddington as to the reason why so many people experienced disappointment in trying to preserve a marine gathering for home examination ; they were in too much of a hurry to put their specimens into water which was unfit to receive them, because it was not at first sufficiently rich in oxygen to afford them support. They all knew how persons at the seaside put things into a glass, and how they found them all go bad in a day or two, whereas if they had prepared the water first it would have been a success. That was a hint to gatherers which they would find useful. He did not pretend to have attained the same success as Mr. Waddington, but he had kept *Crassicornis, Anthia*, &c., and he could certainly recommend all the Members to take up "Marine Aquaria," the possession of which added a new joy to the life of any microscopist.

Mr. Goodwin asked if Mr. White ever tried the plan of obtaining any of the washings of marine fish or of marine shells ? He thought it might be a good way to get minute organisms.

Mr. T. C. White said that some time ago when he was keeping a marine aquarium he got some of the Pecten shells and obtained from them a quantity of ova and other things.

The President was sure they had all listened to the paper and to the remarks which followed it with extreme interest.

The thanks of the meeting were then voted to Mr. Waddington for his paper.

Mr. T. F. Smith read his paper "On Arachnoidiscus as a test for high power objectives."

Mr. Goodwin inquired what was the highest power with which these observations had been made?

Mr T. F. Smith said it was $\frac{1}{6}$in. of 0·96 numerical aperture.

Mr. Goodwin thought it would be a good thing if the Club could provide objectives of that kind for the use of Members who had occasion to use them for special purposes.

The thanks of the meeting were voted to Mr. Smith for his very interesting paper.

Mr. J. D. Hardy exhibited one of Marion's "Academy" Cameras, and described the mode in which he had adapted it to the microscope for the purpose of taking photo-micrographs, specimens of which were handed round for inspection.

Mr. Nelson said that at their last meeting Mr. Hailes handed him a slide of *Amphipleura* mounted in one of the dense media by Prof. Hamilton Smith. He found, however. that the medium was not so dense as that previously shown by Prof. Smith, and that it did not in consequence give so brilliant an image.

Announcements of meetings, &c., for the ensuing month were then made. and the proceedings terminated with the usual conversazione, and the following objects were exhibited :—

Chætophorus elegans	Mr. F. W. Andrew.
Œcidium, sp. on the surface of a leaf	Mr. E. T. Browne.
Photo-micrographs, parasites of seal and of honey bee	Mr. C. Lees Curties.
Terminal leaf bud of Hawthorn, *Cratagus oxycantha*	Mr. H. E. Freeman.
Tran. Sec. Sporacarp of *Pilulina globulifera* ...	Mr. G. E. Mainland.
Floscularia longicaudata	Mr. C. Rousselet.
Arachnoidiscus ornatus	Mr. T. F. Smith.

Attendance—Members, 43; Visitors, 5.

April 13th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Floscularia cornuta ... ... *Stephanoceros Eichhornii*	Mr. F. W. Andrew.
Plumatella repens	Mr. C. G. Dunning.
Jumping spider, *Salticus tardigradus* ♀ ...	Mr. F. Enock.
Sucking stomach of fly (abnormal)	Mr. F. Fitch.
Cross section, flower bud of *Laurustinus* ...	Mr. H. E. Freeman.
Stephanoceros Eichhornii	Mr. E. K. Jacques.
Circulation in nettle sting	Mr. G. E. Mainland.
Stictodiscus adspersus	Mr. H. Morland.
Frog's bladder, injected with silver	Mr. E. M. Nelson.
Hexactinellid sponge, *Autocystis Zettelii* ...	Mr. B. W. Priest.

Plumatella repens	... ...	Mr. C. Rousselet.
Heliopelta	... ...	Mr. T. F. Smith.

Attendance—Members, 41 ; Visitors, 4.

April 27th, 1888.—Ordinary Meeting.

A. D. Michael, Esq., F.L.S., F.R.M.S., &c., Vice-President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club:—Mr. James Russell, Mr. R. J. W. Grindle, and Mr. Andrew Pringle.

The following additions to the Library and Cabinet were announced:—

"The American Monthly Microscopical Journal"	In exchange.
"The Journal of Microscopy"	"
"The Scientific Enquirer"	"
"The Botanical Gazette"	"
"The Journal of the Royal Microscopical Society"	"
"Science Gossip"	"
"Journal of the New York Microscopical Society"	"
Two Vols., "Proceedings Leopold Academy of Hallé"	"
"Journal of the Mitchell Library, Glasgow"...	From the Librarian.
"Annals of Natural History"	Purchased.
Four Slides, Diatoms	From Mr. Kitton.

The thanks of the meeting were voted to the donors.

Mr. B. W. Priest read a short paper "On Some Sponge Spicules found in the Diatomaceous Deposit from Oamaru." The subject was illustrated by a diagram.

Mr. J. G. Waller, in reply to the Chairman, said he had nothing to say which would elucidate the curious phenomena described by Mr. Priest. He had examined the specimens, and could only say they were a great puzzle to him ; they looked as if some minute vermiform creature had got into the spicule and had burrowed along it, but how, it was impossible to say. He thought the perforations seemed more continuous than Mr. Priest had drawn them.

Professor C. Stewart said he had looked at the specimens and thought that the perforations seemed to be discontinuous. It was a remarkable specimen, and well worthy of investigation and study. It was the first time he had seen such a thing.

The Chairman said he had some indistinct recollection of Professor Duncan reading a paper at the Linnean Society upon some sponge spicules which were pierced up the centre in a direction which was not straight, but

yet not exactly spiral. His view was that in almost every instance, there was evidence that the creature—or whatever it was that had made the perforations—had got in at the side, and after making its way in had turned at right angles and then bored longitudinally up the spicule. He stated that a close examination showed in nearly every case a short right angled passage leading from the outside. It was some years ago that the subject came before the Society, so that he did not remember the matter very clearly.

The thanks of the meeting were voted to Mr. Priest for his communication.

The Chairman said they had nothing else to bring before the meeting, so that he hoped someone would be able to start some subject of interest.

Mr. Karop said he had a communication a short time ago from Surgeon Tomes, I.M.D., on the fly-catching habit of *Wrightia coccinea*, the peculiarities of which were explained by means of drawings on the black-board.

Announcements of meetings, excursions, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, the following objects being exhibited :—

Ilyocryptus sorditus	Mr. F. W. Andrew.
Elytron of beetle from British Guiana ...	Mr. E. T. Browne.
British trap-door spider, *Atypus piceus*, ♀ ...	Mr. F. Enock.
Tanypus maculatus, pupal stage	Mr. G. E. Mainland.
Sponge spicules, with silicious organism in axial cavity	Mr. B. W. Priest.
Asplanchna Brightwellii, ♂	Mr. C. Rousselet.
Mange insect of horse, eggs, and larva ...	Mr. W. Walker.

Attendance—Members, 40; Visitors, 4.

May 11th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Argulus foliaceus	Mr. F. W. Andrew.
Pleurosigma angulatum, mounted in Mr. A. E. Mcate's new medium, Bromo-orpiment	Mr. C. Lees Curties.
Early stage of catkin of willow	Mr. H. E. Freeman.
Triceratium Monteryii	Mr. H. Morland.
Euplectella, with floricome spicules *in situ* ...	Mr. B. W. Priest.
Notonecta aurita ... ... *Pterodina patina*	Mr. C. Rousselet.
Eupodiscus argus	Mr. T. F. Smith.

Attendance—Members, 31; Visitors, 2.

May 25th, 1888.—Ordinary Meeting.

Prof. B. T. Lowne, F.R.C.S., F.L.S., &c., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following additions to the Library were announced :—

"The American Naturalist" ... ... In exchange.

"The Scientific Enquirer"	In exchange.
"Proceedings of the Royal Society"	"
"The American Monthly Microscopical Journal"	"
"The Journal of the New York Microscopical Society	"
"The Botanical Gazette"	"
"Report and Proceedings of the Canadian Institute"	"
"Proceedings of the Geologists' Association" ...	"
"Science Gossip"	From the Publisher.
"British Petrography"	Purchased.

The Secretary said he had a matter of interest to mention for the benefit of those who were interested in the study of the Diatomaceæ. Some time ago Mr. Forrester, of the Oamaru Harbour Board, New Zealand, promised to send over some diatomaceous earth for distribution amongst the members. Since then a parcel had arrived from him containing two samples of the deposit, one from Jackson's Paddock and the other from Cormack's Siding. He had brought with him to the meeting some of each sort, from which Members could supply themselves if desired, and if the quantity brought was found to be insufficient, more could be had if wanted. Mr. Forrester had asked in exchange for any specimens of other deposits which Members might be able to furnish him with. He thought that the thanks of the Club were due to Mr. Forrester for so kindly affording them the opportunity of examining for themselves specimens of the earths which were upon the table before them.

Mr. Buffham read a paper "On the Reproductive Organs—especially the Antheridia—of some of the Florideæ." He explained that he had been unable to prepare diagrams with which to have illustrated the subject to the meeting, but the paper when printed in the Journal would be illustrated by three plates.

The President said he was sure all must have listened with great interest to the paper which had just been read, although to some the subject, especially without the figures, would no doubt be, as he felt it to be in his own case, a little beyond them. It was, however, a subject which he should be very glad to know something more about, and should, therefore, be very glad if Mr. Buffham would some day give them a popular paper on the way to study the Florideæ. He knew at present very little about them beyond the facts that they had antheridia and cystocarps, but he should be very glad to have the subject put before him in a way suited to beginners in such a subject.

Mr. Goodwin said that Mr. Waddington had seen something of the growth of algæ in his sea-water aquaria, and he hoped he would bear it in mind that Mr. Buffham was studying these organisms, and would not let it pass if anything of particular interest came under his notice. For when a person took up with an investigation such as that, assistance should be given by all who were able to the utmost extent possible.

The thanks of the meeting were voted to Mr. Buffham for his paper.

Mr. T. F. Smith read a paper "On True and False Images in Microscopy."

Mr. E. M. Nelson said he should just like to mention, by way of correction, one little mistake which Mr. Smith had fallen into, and that was in making the statement that Prof. Abbé's diffraction theory was first published in the "Royal Microscopical Journal." He did not seem to be aware that it was in the first instance absolutely ignored not only by that, but by all the scientific journals of this country, until Dr. Fripp translated it, and got it printed in the "Bristol Naturalists' Journal." There had no doubt been some very objectionable passages written in connection with the subject—not, perhaps, by Prof. Abbé, but in such a way as to appear to put them into Prof. Abbé's mouth, such, for instance, as the statement that because the whole of the diffraction images were not taken in, therefore the whole structure of the object could not be known. That, of course, was absurd on the face of it, and Prof. Abbé did not believe anything of the kind. The diffraction theory did not disturb any of the existent laws; it left them just where they were, coming continuously on and up until a point was reached where mathematical theory showed that the object was beyond the grasp of the lens that was being used. If they had an object within the powers of the lens, then, of course, they would be able to get a true idea of its structure, but if not, then they might get any appearance, according to circumstances. Touch was a very wonderful thing, enabling them to form ideas of the form of objects, but they might as well say that they could know nothing about objects because they could not touch them. With these difficult objects, however, though they could get a fair knowledge of them within the limits of their optical powers, yet they came at length to a point where the largeness of the angle required was such that they could not yet grasp the diffraction spectra, and at that point their entire knowledge necessarily ended.

The President said that he had listened with great interest to the paper and the remarks made upon it; but he feared that justice had not been done to Prof. Abbé's work. With regard to diffraction spectra, very few people understand them, and he did not know that he could make the matter very plain to those who have not studied the subject. Not only is it necessary for the comprehension of this subject to have a competent knowledge of the laws of refraction and vision—mechanical optics—but it is also necessary to know something of the more complex science known as physical optics. The manner of regarding light is quite different in mechanical and physical optics. In the former science a ray of light is represented by a straight line, that is, the direction of the propagation of the light only is taken into account. In physical optics light is regarded as a series of wave-surfaces. The disturbances taking place in planes at right angles to the rays are taken into account. As these disturbances are very minute, the convention that light travels in straight lines is sufficiently accurate, except when the objects seen are very minute and very close together. When sound-waves pass through an aperture they radiate just as they radiate from the point where the sound is produced—this is because the opening is very small in proportion to the waves; with light the same thing takes place with a very small aperture. Suppose, for example, a long wave at sea passing up the channel; it remains

unbroken; yet if the same wave passes between a number of piles it is broken into numerous minute waves, which take various directions and destroy or augment each other. The very minute light waves are similarly dispersed by very minute apertures, such as the spaces between finely-ruled lines, and instead of a pencil of rays travelling in a straight line, it is split up into a fan of light rays. Two such fans from two adjacent apertures overlap each other, and hence from a pair of luminous points, the interspaces between adjacent lines say, rays reach the eye by paths of different lengths; when the difference in the length of the path is half a wave length, there is darkness; when a whole wave length, light; as the waves of the white ray differ in length a series of spectra result. In order to see the object as it really is, it would be necessary to rectify all the paths of all the light rays, which is as impossible as it would be to put together a wave after it has been broken into wavelets by the piles of a pier. As an example of this phenomenon, Barton's buttons may be instanced. A smooth gold button has a metallic appearance, which we all know; rule such a button with fine lines, six or eight thousand to the inch, and it appears like a diamond—that is due to diffraction spectra. If it were possible to re-collect all the rays dispersed by the ruled button, and bring them back to the path which they would have taken had the button been unruled, it is assumed that the metallic appearance of the button would be restored. These are not matters of theory, as Mr. Smith seemed to think, but matters of fact. When we have to deal with diffracted light it is most difficult or impossible to determine the nature if the obstacle producing the diffraction. It is like trying to determine the shape of a pier by studying the little waves produced by its disturbing influence. No doubt if the conditions are identical in two cases the disturbances are identical; hence with a given objective, focus, and illumination, an object will always have the same appearance; but alter any one, ever so slightly, and a totally different structure is observed. However the condition may be varied, the image produced is true, in this sense, it may always be produced with such conditions; but it is not the same kind of image as that which would be produced by a larger object of the same kind; which was, he took to, Mr. Smith's idea of a true image. The subject was one in which, personally, he felt very much interested, and he was therefore glad to have had it brought forward. He felt sure the Members would give a hearty vote of thanks to Mr. Smith for his paper.

Mr. T. F. Smith said, with regard to the remarks of Mr. Nelson, questioning his statement that Prof. Abbé's views were first published in the "Microscopical Journal," he believed that he was wrong, the fact being as stated by Mr. Nelson; but as far as the wording was concerned he had carefully followed it wherever it had been necessary to make any quotations. With regard to the diffraction theory, he had not expressed any opinion upon it either for or against, but what he pleaded for was that they should be at liberty to judge of a thing by what they saw.

The President said that if the diffraction of light was ignored altogether, then, of course, he was out of court entirely.

Mr. Priest read an extract from a letter from Mr. Harris, of Cardiff,

describing an object, exhibited in the room, which had been fished up from a great depth of the sea off Cebu, and the appearance of which he exhibited also by a diagram. He had brought it to ask the opinions of Members as to what it was. His first thought was that it was a piece of Venetian glass, partly decomposed by the action of the sea-water. The effect to which attention was called, was in the interior and not on the surface.

Mr. Waddington said he had examined it, but could not clearly make out that it was glass at all. He thought if a small portion could be broken off for analysis it could easily be tested as to whether it was glass or not.

Mr. Priest said he was not sure that it was glass ; it might be a piece of Obsidian. The specimen was in itself so small that he was afraid it would not be possible to spare any for chemical examination.

Mr. E. M. Nelson read a paper "On the Interpretation of a Photomicrographic Phenomenon by the Abbé Diffraction Theory."

The thanks of the meeting were voted to Mr. Nelson for his communication.

Announcements of meetings, &c., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, the following objects being exhibited:—

Rotifera, Infusoria, &c.	Mr. F. W. Andrew.
Marine algæ, *Chondriopsis tenuissima*, &c. ...	Mr. T. H. Buffham.
Spermatozoa of mouse (Apochromatic $\frac{1}{6}$th) ...	Mr. C. Lees Curties.
Scales from spider (*Salticus scenicus*)	Mr. G. E. Mainland.
Curious object dredged off Cebu...	Mr. B. W. Priest.
Lisunocodium Sowerbii	Mr. C. Rousselet.
Scale of *Morpho Menelaus* (torn)	Mr. T. F. Smith.
Muscle of pig	,, ,,
Egg of stone mite, *Trombidium lapidum* ...	Mr. A. W. Stokes.

Attendance—Members, 47 ; Visitors, 3.

Q.M.C. EXCURSIONS, 1887.

April 2nd.

LIST OF OBJECTS FOUND ON THE EXCURSION TO CHINGFORD, BY MESSRS. HARDY, PARSONS, ROUSSELET, AND SPENCER.

CRYPTOGAMIA. ALGÆ.

Gonium pectorale.
Pandorina morum.

PROTOZOA.

Acineta, sp.
Actinophrys sol.
Actinosphærium Eichhornii.
Anthophysa vegetans.
Bursaria truncatella.
Coleps hirtus.
Dinobryon sertularia.
Euglena viridis.
Oxytricha platystoma.
Paramecium bursaria.
Peridinium tabulatum.
Stentor polymorphus.
Stylobryon petiolatum.
Stylonichia mytilus.
Synura uvella.
Trachelius ovum.
Uroglena volvox.
Uroleptus piscis.

VERMES. ROTIFERA.

Anuræa aculeata.
,, *cochlearis.*
Brachionus rubens.
Conochilus volvox.
Diaschiza semi-aperta.
Dinocharis tetractis.
Floscularia cornuta.
Hydatina senta.
Metopidia lapadella.
,, *solidus.*
Notholca jugosa.
,, *polygona.*
Notommata naïas.
Rotifer macrurus.
,, *vulgaris.*
Salpina mucronata.
Synchæta pectinata.
,, *tremula.*

MOLLUSCOIDEÆ. POLYZOA.

Fredericella sultana.
Plumatella repens, statoblasts of.

Attendance : Eight members of the Club and six members of other Societies. Weather cold and windy.

April 23rd.

Objects Found on the Excursion to the Gardens of the Royal Botanic Society of London, by Messrs. Dunning, Kern, Oxley, Parsons, and Rousselet.

PROTOZOA.

Acineta mystacina.
Actinophrys sol.
Anthophysa vegetans.
Biosœca sp.
Carchesium epistilides.
,, *polypinum.*
Chætonotus larus.
Codosiga botrytis.
Cothurnia spissa.
Dinobryon sertularia.
Diplometa socialis.
Epistylis anastatica.
Euglena acus.
Halteria grandinella.
Litonotus Wrzesniowski.
Opercularia nutans.
Ophrydium Eichhornii.
Pachytrocha cothurnoides.
Phacus longicanda.
Platycola decumbens.
Pleuronema coronata.
Podophrya cylindra.
,, *elongata.*
Pyxicola Carteri.
,, *operculigera.*
Salpingœca, several sp.
Stentor igneus.
,, *Mulleri.*
,, *polymorphus.*
Stichotricha remex.
Thuricola operculata.
Trachelius ovum.
Trachelocerca olor.
Vaginicola crystallina.
Zoothamnium arbuscula.
,, *simplèx.*

VERMES. Rotifera.

Actinurus Neptunius.
Anuræa aculeata.
Asplanchna priodonta.
Brachionus amphiceros.
,, *angularis.*
,, *Bakeri.*
Euchlanis deflexa.
,, *dilatata.*
Floscularia campanulata.
,, *longicaudata.*
,, *ornata.*
Limnias ceratophylli.
Melicerta ringens.
Monostyla cornuta.
Noteus quadricornis.
Œcistes crystallinus.
,, *intermedius.*
,, *Stygis.*
Philodina megalotrocha.
Polyarthra platyptera.
Rotifer macroceros.
,, *macrurus.*
,, *vulgaris.*
Salpina mucronata.
,, *redunca.*
Synchæta tremula.

MOLLUSCOIDEÆ. Polyzoa.

Fredericella sultana.
Paludicella Ehrenbergii.

Attendance: Twenty-three members of the Club, twenty-six members of other Societies, and four friends.

May 7th.

OBJECTS FOUND ON THE EXCURSION TO STAINES, BY MESSRS. H. EPPS, KERN, PARSONS, SPENCER, AND WESTERN.

CRYPTOGAMIA. ALGÆ.

Chætophora elegans.
,, endivæfolia.
,, pisiformis.
Coleochæte scutata.
Microspora vulgaris.
Nostoc macrosporum.
Rivularia granulifera.
Tetraspora gelatinosa.
Vibrio bacillus.

DESMIDIACEÆ.

Closterium acerosum.
,, didymotocum.
,, lunula.
,, moniliferum.
,, setaceum.
Cosmarium margaritiferum.

PROTOZOA.

Actinophrys sol.
Anthophysa vegetans.
Aspidisca costata.
Chætomonas constricta.
,, globulus.
Chætonotus larus.
Coleps hirtus.
Dinobryon sertularia.
Epistylis anastatica.
Euglena viridis.
Euplotes patella.
Folliculina Boltoni.
Halteria volvox.
Loxophyllum meleagris.
Opercularia nutans.
Ophridium versatile.
Paramecium aurelia.
,, bursaria.
Stentor Mulleri.
,, polymorphus.
Uroleptus musculus.
Vorticella campanula.
,, chlorostigma.
,, microstoma.
,, nebulifera.

VERMES. ROTIFERA.

Anurea aculeata.
Asplanchna Brightwellii.
Brachionus pala.
Cœlopus porcellus.
Diglena grandis.
Dinocharis pocillum.
Euchlanis triquetra.
Floscularia ambigua.
,, campanulata.
,, cornuta.
,, ornata.
Furcularia longiseta.
Mastigocerca elongata.
,, rattus.
Melicerta ringens.
,, tubicolaria.
Metopidia lepadella.
Œcistes crystallinus.
Philodina citrina.
,, erythrophthalma.
,, megalotrocha.
Polyarthra platyptera.
Pterodina patina.
Rotifer macroceros.

Rotifer tardus.
,, *vulgaris.*
Salpina mucronata.
Salpina redunca.
Stephanoceros Eichhornii.
Synchæta pectinata.

Attendance: Twelve members of the Club and six members of other Societies. Fine day.

May 21st.

Objects Found on the Excursion to Totteridge, by Messrs. Dunning, Kern, Parsons, Rousselet, Spencer.

CRYPTOGAMIA. Algæ.
Apiocystis Brauniana.
Chætophora elegans.
Gonium pectorale.
Desmidiaceæ.
Arthrodesmus convergens.
Closterium Griffithsii.
,, *lunula.*
,, *moniliferum.*
PROTOZOA.
Actinophrys sol.
Amphileptus fasciola.
Anthophysa vegetans.
Arcella aculeata.
,, *vulgaris.*
Bursaria truncatella.
Chætonotus larus.
Coleps hirtus.
Cothurnia imberbis.
Dendromonas virgaria.
Difflugia proteiformis.
Dileptus folium.
Dinobryon sertularia.
Epistylis anastatica.
Litonotus fasciola.
Opercularia nutans.
Paramecium bursaria.
Scyphidia physarum.
Spirostomum ambiguum.
Stentor Mulleri.
Stentor niger.
,, *polymorphus.*
,, *Ræselii.*
Trachelius lamella.
Vaginicola crystallina.
Vorticella campanula.
,, *nebulifera.*
VERMES. Rotifera.
Anuræa aculeata.
,, *curvicornis.*
,, *serrulata.*
,, *tecta.*
Brachionus Bakeri.
,, *pala.*
Colurus deflexus.
Dinocharis pocillum.
,, *tetractis.*
Euchlanis triquetra.
Floscularia ambigua.
,, *campanulata.*
Furcularia gracilis.
Mastigocerca elongata.
Melicerta ringens.
Monostyla lunaris.
Œcistes crystallinus.
,, *umbella.*
Philodina megalotrocha.
Pterodina patina.
Rotifer macroceros.
,, *vulgaris.*

Salpina mucronata.
Stephanoceros Eichhornii.
Synchæta pectinata.
Triarthra longiseta.

Attendance : Nine members of the Club and two members of other Societies. Very showery and hailstorms.

June 4th.

OBJECTS FOUND ON THE EXCURSION TO WOKING, BY MESSRS. J. T. POWELL, SPENCER, AND WESTERN.

PHANEROGAMIA.

Carex glauca.
,, *Goodenowii.*
,, *panicea.*
,, *pilulifera.*
Drosera intermedia.
,, *rotundifolia.*
Luzula campestris.
Pedicularis sylvatica.
Polygala vulgaris.
Ranunculus flammula.
Scirpus cæspitosus.

PROTOZOA.

Actinophrys sol.
Anthophysa vegetans.
Ophrydium sessile.
,, *versatile.*
Stentor polymorphus.
Trachelocerca olor (var. *viridis*).
Vorticella campanula.
,, *chlorostigma.*
,, *nebulifera.*

VERMES. ROTIFERA.

Anuræa cochlearis.
Asplanchna priodonta.
Dinocharis pocillum.
Floscularia ambigua.
,, *cornuta.*
,, *ornata.*
Furcularia longiseta.
Limnias ceratophylli.
Melicerta ringens.
Notommata tripus.
Œcistes crystallinus.
Polyarthra platyptera.
Rotifer vulgaris.
Stephanoceros Eichhornii.
Synchæta tremula.

Attendance : Five members of the Club and two members of other Societies. Weather fine.

June 18th.

OBJECTS FOUND ON THE EXCURSION TO WHITSTABLE, BY MR. HARDY.

CŒLENTERATA. HYDROZOA.

Campanularia volubilis.
Plumularia pinnata.
Tubularia indivisa.

ACTINOZOA. CTENOPHORA.

Pleurobrachia (= *Cydippe*) *pileus.*

ECHINODERMATA. ASTERIDIÆ.

Solaster papposa.

OPHIURIDEA.

Ophiurus albidus.

VERMES. POLYCHÆTÆ.

Aphrodita aculeata.

Attendance: Thirteen members of the Club and seven members of other Societies.

July 2nd.

OBJECTS FOUND ON THE EXCURSION TO WALTON, BY MESSRS. E. T. BROWNE, KERN, AND WESTERN.

CRYPTOGAMIA. ALGÆ.
Batrachospermum moniliforme.
DESMIDIACEÆ.
Closterium acerosum.
" *moniliferum.*
Cosmarium tetraophthalmum.
DIATOMACEÆ.
Fragillaria capucina.
Pinnularia nobilis.
PROTOZOA.
Actinophrys sol.
Actinosphærium Eichhornii.
Amphileptus anser.
Anthophysa vegetans.
Carchesium polypinum.
Cephalothamnium cæspitosum.
Epistylis plicatilis.
Lembadion bullinum.
Litonotus fasciola.
Peridinium tabulatum.
Stentor igneus.
" *Mulleri.*
" *polymorphus.*
Stylonichia mytilus.
Trachelius ovum.
Vaginicola crystallina.
Vorticella campanula.
" *microstoma.*
" *nebulifera.*
Zoothamnium simplex.
PORIFERA.
Spongilla fluviatilis.

VERMES. ROTIFERA.
Anuræa aculeata.
" *cochlearis.*
Brachionus Bakeri.
Conochilus volvox.
Euchlanis dilatata.
" *triquetra.*
Floscularia cornuta.
" *ornata.*
Lacinularia socialis.
Limnias ceratophylli.
Melicerta ringens.
Œcistes crystallinus.
" *intermedius.*
" *Stygis.*
Philodina citrina.
" *erythropthalma.*
Polyarthra platyptera.
Proales sordida.
Rotifer hapticus.
" *macroceros.*
" *vulgaris.*
Stephanoceros Eichhornii.
Synchæta tremula.
CRUSTACEA. ENTOMOSTRACA.
Alona quadrangularis.
MOLLUSCOIDEÆ. POLYZOA.
Alcyonella fungosa.
Fredericella sultana.
Plumatella repens.

Attendance: Eleven members of the Club and four members of other Societies. Fine day. Hot.

July 16th.

OBJECTS FOUND ON THE EXCURSION TO LOUGHTON, BY MESSRS. KERN AND WESTERN.

CRYPTOGAMIA. ALGÆ.

Pediastrum Boryanum.
Scenedesmus quadricauda.
Spirogyra quinina.
Volvox minor.

DESMIDIACEÆ.

Closterium Jenneri.
Cosmarium Brebissonii.
Desmidium Swartzii.
Docidium nodulosum.

PROTOZOA.

Actinosphærium Eichhornii.
Anthophysa vegetans.
Difflugia oblonga.
,, *proteiformis.*
Epistylis flavicans.
Euglena viridis.
Platycola decumbens.
Stentor Mulleri.
Stylonichia mytilus.
Synura uvella.
Thuricola operculata.
Vaginicola crystallina.
Vorticella campanula.
,, *spectabilis.*

VERMES. ROTIFERA.

Brachionus Bakeri.
Dinocharis pocillum.
Floscularia campanulata.
,, *ornata.*
Limnias ceratophylli.
Monostyla lunaris.
Philodina citrina.
,, *megalotrocha.*
Pterodina patina.
Rotifer macroceros.
,, *tardus.*
Salpina eustala.
Stephanoceros Eichhornii.

Attendance: Six members of the Club and three members of other Societies. A slight shower in afternoon, otherwise fine.

September 3rd.

OBJECTS FOUND ON THE EXCURSION TO RICHMOND, BY MESSRS. KERN AND ROUSSELET.

CRYPTOGAMIA.

ALGÆ. DESMIDIACEÆ.

Closterium aciculare.
,, *costatum.*
,, *cynthia.*
,, *Dianæ.*
,, *lunula.*
Closterium moniliferum.
Cosmarium Turpini, var. *cambricum.*
Staurastrum muricatum.

PROTOZOA.

Actinophrys sol.
Anthophysa vegetans.

Astasia trichophora.
Chætospira Mulleri.
Codosiga botrytis.
Cothurnia imberbis.
Dinobryon sertularia.
Diplometa socialis.
Enchelys arcuata.
Monosiga Steinii.
Rhipidodendron Huxleyi.
Spirostomum ambiguum.
Stentor Mulleri.
,, *Roeselii.*
Trachelius ovum.
Trachelocera olor.
Vaginicola crystallina.
Vorticella campanula.

VERMES. Rotifera.

Anuræa cochlearis.
Brachionus Bakeri.
Cœlopus porcellus.
,, *tenuior.*
Colurus caudatus.
Diglena catellina.
Dinocharis pocillum.
Euchlanis deflexa.
Floscularia campanulata.
,, *cornuta.*
,, *ornata.*
,, *regalis.*
Furcularia ensifera.
Limnias ceratophylli.
Mastigocerca carinata.
,, *elongata.*
Melicerta conifera.
,, *ringens.*
Metopidia lepadella.
Monostyla lunaris.
Notommata tripus.
Œcistes crystallinus.
Philodina megalotrocha.
Pterodina patina.
Rotifer tardus.
,, *vulgaris.*
Salpina eustala.
Stephanops lamellaris.
Stephanoceros Eichhornii.

CRUSTACEA. Entomostraca.

Sida crystallina.

Attendance : Seven members of the Club.

September 17th.

Excursion to Keston Common. Wet day. The only persons who went were three members of the Excursions Sub-Committee. The rain prevented any collecting being done by them.

October 1st.

Objects Found on the Excursion to Rye House, by Messrs E. T. Browne, Kern, and Rousselet.

CRYPTOGAMIA.

ALGÆ. Desmidiaceæ.

Closterium costatum.
,, *Dianæ.*
Closterium lunula.
,, *striolatum.*
,, *turgidum.*

PROTOZOA.
Acineta mystacina.
Actinophrys sol.
Actinosphærium Eichhornii.
Anthophysa vegetans.
Carchesium polypinum.
Chætonotus larus.
Cothurnia imberba.
Dendromonas virgaria.
Dinobryon sertularia.
Epistylis flavicans.
,, *nutans.*
,, *plicatilis.*
Litonotus fasciola.
,, *Wrzesniowski*
Loxodes rostrum.
Loxophyllum meleagris.
Platycola longicollis.
Stentor Mulleri.
,, *polymorphus.*
Vorticella nebulifera.
Zoothamnium arbuscula.
VERMES. Rotifera.
Brachionus Bakeri.
Cœlopus tenuior.
Colurus caudatus.
Copeus cerberus.
Diaschiza semi-aperta.
Dinocharis pocillum.
Euchlanis deflexa.
,, *macrura.*
,, *triquetra.*
Floscularia cornuta.
,, *ornata.*
,, *regalis.*
Furcularia longiseta.
Mastigocerca bicornis.
,, *carinata.*
Metopidia oxysternum.
,, *solidus.*
Monostyla Lordii.
Noteus quadricornis.
Œcistes crystallinus.
Philodina megalotrocha.
Polyarthra platyptera.
Pterodina patina.
Rattulus tigris.
Rotifer macroceros.
,, *macrurus.*
,, *vulgaris.*
Scaridium longicaudum.
Stephanoceros Eichhornii.
CRUSTACEA. Entomostraca.
Sida crystallina.
ARACHNIDA.
Macrobiotus.

Attendance: Nine members of the Club and six members of other Societies. Weather threatening.

October 15th.

Objects Found on the Excursion to Wood Street, by Messrs. Kern and Rousselet.

PROTOZOA.
Didinium nasutum.
Euglena viridis.
Litonotus fasciola.
Loxophyllum meleagris.
Nassula ornata.
Peridinium tabulatum.
Prorodon teres.
Rhipidodendron Huxleyi.
Stentor Mulleri.

Stentor polymorphus.
Syncrypta volvox.
Trachelius ovum.
Trachelocerca olor.
Trichodina pediculus.
VERMES. ROTIFERA.
Anuræa brevispina.
,, *curvicornis.*
Brachionus rubens.
Cœlopus tenuior.
Copeus cerberus.
Diaschiza semi-aperta.
Dinocharis pocillum.
Euchlanis deflexa.
,, *triquetra.*
Furcularia longiseta.
Mastigocerca elongata.
,, *rattus.*
Metopidia solidus.
Monostyla lunaris.
Notommata pilarius.
Philodina citrina.
Polyarthra platyptera.
Proales parasita.
Rotifer macrurus.
,, *vulgaris.*
Salpina brevispina.
,, *macrantha.*
,, *mucronata.*
Synchæta pectinata.
,, *tremula.*

Attendance : Two members of the Club and three members of other Societies.

FREDK. A. PARSONS,
Hon. Sec. Excursions Sub-Com.

On the Structure of the Valve of Pleurosigma.

By T. F. Smith.

(*Read September 28th,* 1888.)

Plate XXIII.

From the time since the development of the microscopic objective rendered the study possible, two rival schools of microscopists have brought their observations to bear on the question of diatom structure, with the result that one school soon saw nothing but beads, and the other nothing but perforations. On account of their coarser structure—that is of the primary—the so-called markings of such diatoms as *Triceratium* and *Coscinodiscus* were at an early date settled as being unmistakably perforations; but the structure of the finer forms, such as *Pleurosigma*, still remains with many an open question. The two opposite schools of interpretation were well represented here, in one night, by Messrs. Morland and Deby, who both read papers on "Diatom Structure."* Indeed, I may say that a third and newer school was represented, for Mr. Deby, after going into detail to prove that the diatom frustule is in all cases an hermetically closed envelope, proceeded to caution observers to remember that, owing to the objective not taking up all the diffraction spectra, the character of the image is likely to be something very different from the real structure. This last theory is the negation of all belief; but in spite of it I think the opinion of the majority of those who have given their minds to the study, has crystallized into the form that diatoms are built up, mostly, of perforated plates of silex, and may consist of one or more layers; combining thus great strength with lightness and economy of materials. But it is one thing to formulate a theory, and quite another to make facts agree with it; and fix it how you may, there are some outstanding appearances which refuse to lend themselves to the theory of perforations, and leaves the mind in a state of perplexity on the subject.

I believe I betray no confidence if I say that Mr. Nelson him-

* "Journ. Q.M.C.," Ser. II, Vol. ii, pp. 297 and 308.

self, who has done so much work on the diatom valve, has never seen the "postage stamp" edge on a fractured specimen of *Pleurosigma formosum*, but only the usual series of circles bulging outwards. For myself, I may say that although prepared from analogy to regard the structure of *Pleurosigma* as perforated, the absence of anything like notches at the broken edge of some of them caused me to consider it as an open question only, and to put down the appearance of "beads" in this position as due either to an aggregation of particles outside the resolving faculty of our lenses, or to a confusion of image arising from the existence of more than one layer of material.

With me the matter rested there, but the recent acquisition of the highest optical appliances at present attainable, has led me to try to solve the problem afresh, and I beg to-night to lay before you the results of my investigations.

The valve over which the toughest battles have been fought has been that of *Pleurosigma angulatum*, but I propose to begin with *Pleurosigma formosum*, as being the coarser form, and also the one likely to yield up the most interesting results.

On looking at this diatom, mounted in balsam, a most striking object is seen; but, consequent on the finer structure being obliterated by that method of mounting, for all points of study it is useless. I suppose it is for this reason that but little is read about it now; for one has only to look at one of the plates in Dr. Carpenter's work, showing the different appearances it presents when illuminated from different directions, to see how it must have puzzled microscopists when formerly mounted dry.

To make out the structure with a dry lens, on a dry-mounted slide, is almost impossible, and even when examined thus with Zeiss' apochromatic oil-immersion, the first view seems confusion worse confounded: each valve differing from its fellow, and agreeing in no particular—not even in colour—with the same diatom mounted in balsam; a further study, however, reveals that what appeared so simple, when mounted in the latter, is very elaborate in reality, and the apparently simple plate of silex resolves itself into several layers of structure. The two outer layers—one on each side of the diatom—differ in their ultimate structure, but primarily are composed of a square grating with

bars at right angles to the length and breadth of the valve. One—I cannot tell whether on the inner or outer side—is very delicate, and seems simply a support for a series of small rings, set diagonally on it; which rings, being placed immediately over another set of beads or perforations, impart a reddish tinge to that side of the valve, and a general appearance of indefiniteness. The grating on the other side is more robust, and seems to be a plate of silex, with square perforations, frequently filled at the corners with a secondary deposit, thus forming a round hole. I do not claim to have discovered this grating, as Mr. Nelson mentions it repeatedly, but what I do claim to have discovered, is that each alternate hole throws an image in a different focal plane. With the apochromatic $\frac{1}{12}$in., the one set are of a pale red, on the same plane as the grating, and are, I believe, simply the perforations themselves in the middle of each alternate square. The other series of beads are blue, and thrown inwards from each alternate hole in the grating. It is only when the valve is acted upon in some way—by moisture, I presume—that the grating is visible, and in that state, while the red ones are perfect, the blue seem mostly obliterated, but enough remain to determine the relative positions of the two sets. When, however, that side of the valve is perfect, the grating disappears, and its place is taken up with red perforations inwards and white interspaces, which, on focussing inwards, turn into blue beads, giving thus two complete sets of secondary structure, similar in shape, but different in colour, and in the position they occupy.

As far as the outer layers are concerned, I am sure of my ground. I am also sure of this middle plane of blue "beads," and, I think, also of another diagonal grating; but I do not know if this is the whole of the structure. You are in this position with an oil-immersion objective, on an object mounted dry. If the slightest layer of air intervenes between the different parts of the structure you cannot focus through; and if it is mounted in balsam the finer parts are obliterated altogether. Neither do I know if the middle layer of blue "beads" is made up of focal images only, or is composed of hollow hemispheres of silex, with the base of each resting on the outer, and the rounded tops thrust into each square of the middle, diagonal grating. Of one thing I am sure. It is this middle layer of

blue "beads," appearing at the edge of the fractures, which prevents a "postage stamp" edge from being seen. I have been fortunate enough to find one valve, and one only, with a fractured end, which clearly shows the red markings to be perforations, and have got it under the microscope to-night for your inspection. Most of the blue "beads" are wanting, but enough remain to show their relative positions and focal planes. And I beg to call your attention to this peculiarity—that the valve is broken through at the end, part in a straight line, and a part at each side sloping outwards. On the straight part are five or six notches inwards, leaving no doubt as to the structure; but where the fracture slopes diagonally are two rows of beads—one on each side—with the bulges outwards. The explanation is that the valve is hollow in section, and, the objective being focused on the middle, the structure is penetrated at the sides, and comes upon the inner layer of blue beads. I offer this theory of hemispheres for the middle plane as a possible one only, and one which may explain appearances difficult to be accounted for else. On a slide of these diatoms belonging to me, mounted in balsam, is a crushed valve, showing isolated "beads." To accept them as isolated perforations would be difficult to one not possessing the lively imagination of the Irishman, who explained how they made a cannon by taking a large hole and pouring metal around it.

One wishes, in treating this subject, they could imitate the confidence of the microscopists of only nineteen years ago in explaining the structure of diatoms. The Rev. J. B. Reade, in his paper on "The True Form of Diatom Markings," when describing the "beads" of *Pleurosigma formosum*, as shown by his diatom resolver, says:—"Here they are; I can number them, I can weigh them, I can measure them." It is a somewhat humiliating fact that in this present year of grace, after the use of a glass such as the then President of the Royal Microscopical Society never dreamt of, I can only offer the presence of beads or hemispheres in one of the focal planes as a possible theory. This, of course, shows one side of the valve only, but I had the honour of showing the delicate membrane on the other side at the last gossip night but one, and to-night produce a negative and some prints for your inspection. The delicate grating, with the round rings, is seen in the prints as a

long triangular piece by the side of the median line. At that particular place, in the actual specimen, the valve is cracked half across, and a part has sunk down, leaving the piece of delicate structure adhering to the cover. Some gentlemen are here to-night who have examined the specimen under the microscope, and can prove that all the valve was there.

Here, then, I think, is sufficient evidence to prove that each valve of *Pleurosigma formosum* is built up, not of one but, of several layers of structure, and I for myself should feel no hesitation in asserting, from analogy alone, that all the valves of the different species of *Pleurosigma* possess at least a double structure. I have not trusted to analogy, however, but have been fortunate enough to discover, by direct evidence, that the valves of five other species at least have a compound structure, viz., *P. decorum*, *P. balticum*, *P. angulatum*, and two species from Richmond, Virginia. I hope by-and-bye to be able to demonstrate compound structure in the other species, but at present am waiting for materials.

It is not my intention to go minutely into the structure of each particular species, as the photographs will somewhat explain themselves; but I wish to dwell a little on that of *Pleurosigma angulatum* as being the diatom around which most discussion has arisen. In treating of this diatom an initial mistake has been made, by both schools, in assuming the structure to be regular, when in truth nothing can be more irregular than the so-called markings. Dr. Anthony called attention to this in the 5th Vol. of the Monthly Microscopical Journal, and figures the different appearances it presents at the ends and middle of the valve. The drawing is a very fine one, and as an interpretation of the image has but one fault—that it is all wrong. In his drawing the "beads" go close up to, and butt against the median line; but in reality a row of perforations larger than the others runs parallel to it on each side, and a similar row along each outside margin of the valve. Besides this, on almost every valve are parts where the partitions between the perforations are absent—nearly always at the ends, and often in the middle—and it is this peculiarity which has enabled me to determine the existence of a double structure on this diatom. At one focus you will see the "markings" regular, and then, by merely raising or lowering the focus, its

character completely changes. But more convincing than all is, I think, a valve which displays a crack right across a certain part; but is found to be sound when the focus is shifted.

My opinion is that the "hexagons," which have so long puzzled microscopists, points to the true structure of this diatom, and that each valve is composed of two such layers, the one super-imposed on the other.

So far I recognize three types of structure in the *Pleurosigma*. First, a valve composed of two layers of square grating, such as *Pleurosigma balticum;* secondly, a valve with two layers of grating, with secondary markings placed diagonally, such as *Pleurosigma formosum;* and, thirdly, a valve with two layers of net-like structure, such as *Pleurosigma angulatum*; and to one or the other of those types, I think, all the species may be referred.

In itself it may not be considered of great scientific importance, whether a diatom possesses one, or more layers of structure, although even here, if a fact has to be known at all, it is well to know it accurately; but to me, its chief importance is to be found in the lessons it teaches on the interpretation of microscopic images generally. It teaches: First, that the want of agreement of appearance with any particular theory, arose, not from the impossibility of the objective giving a correct image, but because the theory itself was wrong, and mistook a part for the whole; and, secondly, it teaches that the last word has not yet been said on any structure, until it has been thoroughly examined with an objective of the widest aperture. The last word will not have been said even then, nor after the use of any glass that will not show us the arrangement of atoms which distinguishes living from non-living matter; but it will tell us this much, that although the structure shown may be only the aggregation of parts altogether beyond the ken of any objective, it will at least show those groupings in the right place.

EXPLANATION OF PLATE XXIII.

FIG. 1. One of the outer membranes, consisting of a delicate grating composed of alternate rings and squares.

„ 2. Outer membrane on other side of valve, consisting of a square perforated grating.

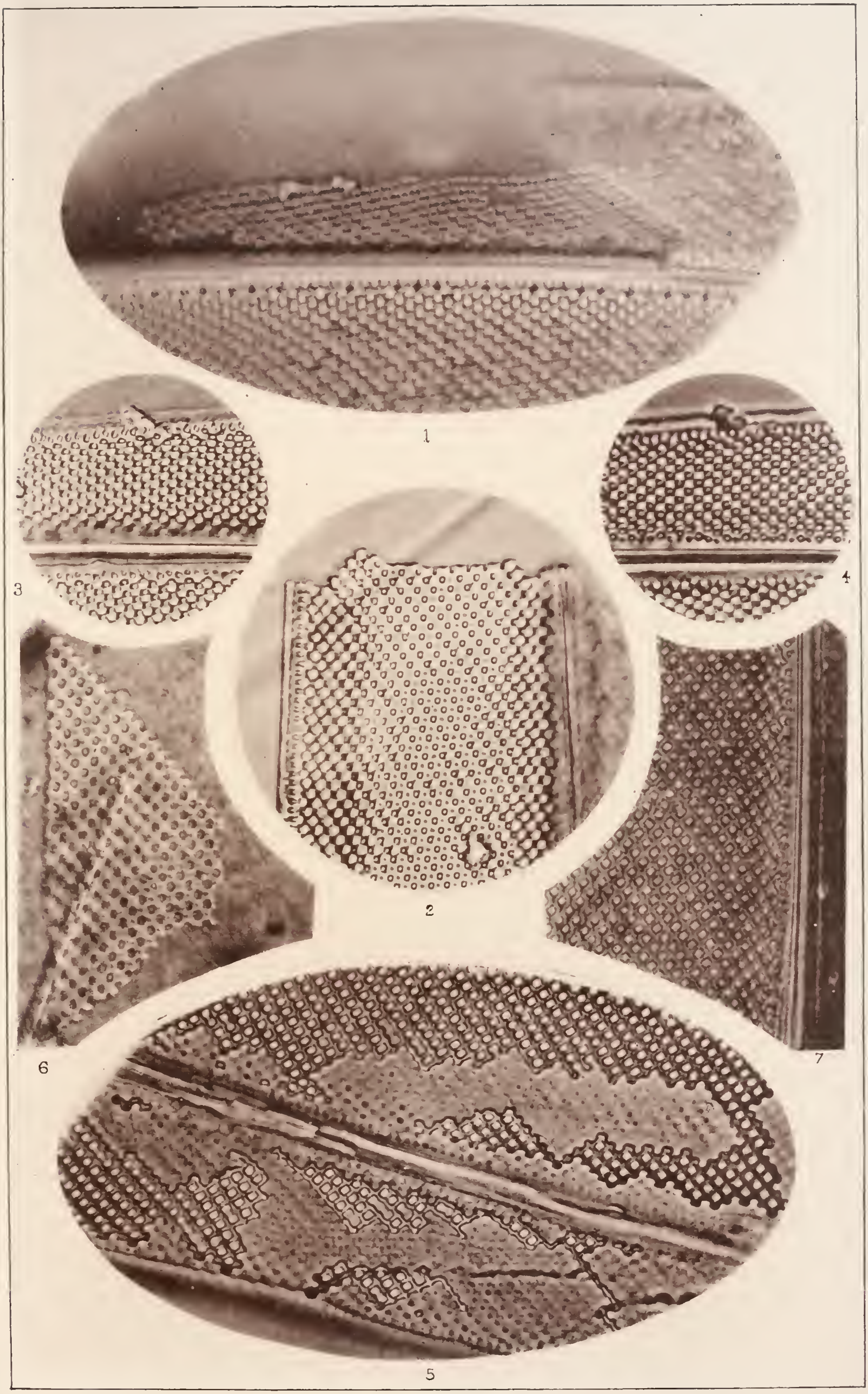

1
3
2
4
6
7
5

Fig. 3. Upper plane of red "beads," thrown by each alternate hole of grating, Fig. 2; on lowering the focus white interspaces turn into blue beads.

„ 4. Lower plane of blue beads thrown from remaining holes of grating shown in Fig. 2; on raising the focus white interspaces turn into red beads.

„ 5. Middle layer of diagonal grating showing torn structure.

„ 6. Fragment of middle layer found on same slide.

„ 7. Middle layer in sound valve lying immediately under delicate membrane, similar to that shown in Fig. 1.

Object glass used, Zeiss's apochromatic oil immersion, $\frac{1}{12}$ inch N.A.1.40, magnifying power 1,750 diameters.

On the Formation of Diatom Structure, II.

By E. M. Nelson.

(*Read September 28th*, 1888.)

Plate XXIV.

In my previous paper on this subject, which you thought worthy of insertion in the Journal,* I expressed an opinion that the structure of *Coscinodiscus Janischii*† indicated a growth from the centre outwards. I have lately found further evidence in confirmation of this opinion.

When examining a *Coscinodiscus diorama*, with my apochromatic $\frac{1}{8}$, I found the following details:—

The immediate centre of the valve is composed of structureless silex.

Proceeding from the centre to the periphery we come to the primary areolations.

They are small at first and well separated from each other, they get larger and closer the further you get from the centre, and eventually they assume the usual polygonal form.

The secondary structure is exterior to the primary areolations which are nearest to the centre of the valve, as in Plate xxiv, Fig. 1.

As we proceed outwards we find the secondary structure on the edge of the primary areolations, as in Fig. 2.

At the periphery the secondary structure is inside the primary areolations, it resembles Fig. 3, which is like a fine *Coscinodiscus asteromphalus*.‡ It will be noticed that in Fig. 3 the structure is complete with the sieve like membrane inside the circle of small holes. I lose this sieve membrane a short distance from the periphery towards the centre of the valve; none is shown at Fig. 2.

There is yet another point, viz., no eye spots can be detected

* "Jour. Q.M.C.," Ser. ii, Vol. 3, p. 201.

† Plate xviii. Fig 1.

‡ "Jour. Q.M.C.," Ser. ii, Vol. 2, Plate xvii, Fig 1.

in the areolations near the centre of the diatom. As we advance to the outer zones we find them faint at first and complete at the periphery. We have then a discoid valve, the structure of which is elementary in the centre and complex at the periphery.

Before closing this paper I wish to announce the discovery of the following secondary structures :—

1. A bar dividing the areolations in *Navicula lyra*. The bar is parallel to the raphæ. This bar is one of the most delicate of diatomic structures with which I am acquainted, and requires hypercritical microscopy for its resolution. There is also a faint kind of mark between the rows of holes. In the Figure this is a little too dark and a little too broad. Fig. 4.

2. Minute perforation in *Rylandsia biradiata*. Fig. 5.

3. Fig. 6 shows an areolation of *Eutogonia Davyana*.

4. In *Coscinodiscus concavus* there is an exceedingly delicate perforated membrane. It differs from the Asteromphalus type in not having a circle of larger perforations round the primary areolation. The secondary structure resembles that on *Triceratium fimbriatum* only it is far finer, and, like that diatom, it is best seen from the inside of the valve. That on my own specimen is the finest perforated membrane with which I am acquainted. Fig. 7.

Thus far these observations are original.

Fig. 8 shows the secondary structure on *Rhabdonema arcuatum*. This has been figured before, but the drawing does not agree with my view of the object.

Some Observations on the Human Spermatozoon.

By E. M. Nelson.

(*Read September 28th*, 1888).

Plate XXIV.

Thoughtful minds are to a certain extent paralyzed, so to speak, when contemplating either the very great or very small. Who on viewing through a telescope the nearest known fixed star in the northern hemisphere (61 Gyni) has not felt a peculiar dread stealing over him when he remembers that the hundreds of billions of vibrations per second falling on the nerve terminals in his eye, thus producing the sensation called light, were originated in that star some three or four years ago? What must be the distance of that star as compared with the size of our earth, light travelling at a velocity equal to nearly eight times the circumference of the earth in one second of time? Even the grandeur of terrestrial phenomena is too little realized by us. It is only when we are aroused by an awful cataclysm like that which has recently occurred in Japan* that we comprehend even in a very imperfect manner the magnitude of the natural forces of our environment.

Leaving the very great we shall find that the same mental impressions are produced even in a greater degree on the contemplation of the very small, because we seem to be more in touch with them.

A man who, during the microscopical examination of a human spermatozoon, remembers that such a minute organism is capable of fertilizing an ovum, and of producing an individual, possessing the same physical and, what is far stranger, the same mental and perhaps moral qualities as his parent, together with, it may be (this point must not be lost sight of), the

* A correspondent, who visited the scene shortly after the volcanic eruption, writing to the "Times" of September 11th, 1888, describes a river of mud, headed by a bore wave, 150-200 feet high, advancing a mile a minute and devastating 30 square miles of land.

diseases of a grandfather, and does not feel in the presence of a mighty force, must be indeed, steeled to insensibility. It is strange that this object, so interesting on account of its intimate connection with ourselves, should have been so slovenly microscoped. The drawings of the human spermatozoon are only up to the microscopy of early achromatic days. A few years ago special attention was given to this object by the announcement that a dorsal appendage had been observed on the tail of the human spermatozoon, similar to that on the newt.* I went into the matter very carefully at that time with the best lenses and apparatus of that day, but failed to see any such appendage. Further, the author of the paper showed me the specimens, but was unable to demonstrate the dorsal appendage. While working at this question I discovered the joint in the tail, or, more strictly speaking, at the point where the tail is joined to what I have termed the stem, and this discovery I communicated to the Club in 1882. Since that date, thanks to the Abbé Zeiss' apochromatics, the curtain which hides the very small from our gaze has been drawn up a little higher. I am, on this account, in a position to put before you a more complete description of this interesting object.

Before entering on this description, however, it is necessary to point out that there are great variations in the form of the spermatozoa. The drawing I now place before you is that of a type constructed from a careful consideration of a great number of slightly differing forms.

Spermatozoa may appropriately be likened to mushrooms. No two mushrooms are precisely alike: one has a longer stem than another, one a thicker stem, and so on; but there is a peculiar point in which mushrooms differ from one another and which has its exact counterpart in the spermatozoon. Where

* "Quar. Jour. Micro. Sci.," Vol. xx, n.s., No. 79, July, 1880; see also Vol. xix, n s., No. 76, October, 1879. I find that the dorsal appendage does not extend beyond the tail, as shown in the plate, but merges into it near the point. The description in the letterpress is also misleading, as it describes a filament joined to the "body" (which I have called "the tail") by a membrane. In reality there is no filament. What has been mistaken for a filament is the microscopical appearance of the edge of the membrane. An edge is always thickened and blackened in the microscope. This is, therefore, an error not only in a certain special case, but in the fundamental principles of the interpretation of microscopical images, and is one that is repeatedly made. I am acquainted with a certain organism erroneously figured and described, and in consequence erroneously named, owing to this very error in microscopical observation.

that part of the head of the young mushroom which eventually becomes the periphery of the fully grown head breaks away from the stem it leaves a ring round the stem with more or less fragments of the edge of the head adhering to it. We shall find our analogy to this in what I have termed the calyx of the spermatozoon.

Our ignorance with regard to the nature of the spermatozoon is proved by the paucity of names we have for its various parts. A machine capable of making a watch is necessarily very complex; but that a machine which shall make a watch capable of making another watch must be much more complex has been pointed out by Paley. A watch-making machine we know all about, and there is a whole vocabulary of names for its various parts. What shall we say, then, for that which by parity of reasoning must be the most complex of all complex machines? I fear that three names will exhaust all that has hitherto been known about it, viz., a head, a tail, a nucleus. Now, however, I hope to increase this vocabulary.

To begin with, the head, which I have called the spore, has not been, to my mind, correctly figured hitherto.

Viewed in its flattened aspect its anterior end is very blunt, not unlike the point of a table knife.

In outline it is like an egg, the posterior part towards the tail being the small end. In all the drawings I have met with the reverse of this is represented. The edge view shows that it is very slightly concave on its under and convex on its upper side. It is therefore something like the half of a converging meniscus seen in section.

The spores vary slightly in size, but I regard the large end of an egg view of the flat side an unmistakably constant feature.

The spore fits into a cup just as an egg or an acorn fits into a cup; the small end of the egg being in the cup. When on the flat that portion of the spore which is exterior to the cup is often broader than the cup.

The outline of the head has always been represented as unbroken, but the edge of the cup can be distinctly seen both in front and side views.

At the bottom of the cup there is what I have termed the calyx. This is exceedingly variable, sometimes it is absent, and sometimes half the size of the whole spore. Figs. 9 and 10, Plate

xxiv, exhibit what may be termed an average amount of calyx. Next we come to the stem, which is a short piece between the cup and the tail proper. This is variable in thickness, being sometimes much thicker than the tail and sometimes of the same thickness. There is another variation in this part of the spermatozoon. This occurs at the end of the stem immediately preceding the break which I have called the joint. At this point it usually thickens, though in some few instances I have been unable to detect any such thickening.

The joint is always present; the amount of the opening, however, is variable.

The connecting bar between the stem and the tail I have drawn dark, as I see it; it may not be necessarily any darker than the stem or the tail; the close approximation of its two edges would account for its dark appearance. The upper part of the tail is usually as shown in the figure, but occasionally I have found a thickening similar to that at the end of the stem. The upper part of the tail is, on the average, slightly thinner than the stem. On the tail I have not been able to detect the smallest appearance of a dorsal appendage. The tail I should regard as fairly constant in thickness and length; on this point I speak from estimation, not from measurement. I have now another new feature to bring before you, and that is the discovery of a filament on the spore. I use the term filament in contradistinction to flagellum, although it closely resembles that of a bacterium, because I regard it as a director, pointer, or kind of antenna for the purpose of guiding the spore into an aperture in the ovum.*

The filament is considerably finer at its root than the tail is at its point.

In the spore you will notice a nucleus with a divided nucleolus; this is drawn from actual observation. It will form a kind of test object, for unless you can see the division in the nucleolus there is little chance of a sight of the filament. In the observed example the division in the nucleolus was smaller than either of the nucleoli themselves. After careful estimation I concluded that it was a $\frac{1}{4}$ or $\frac{1}{5}$ of the diameter of one of the nucleoli. On measurement I found the diameter of the nucleus was $\frac{1}{18000}$ inch

* "Bees and Beekeeping," by F. R. Cheshire, Vol. i, pp. 224, 231. The spermatozoon of the bee has a larger but similar filament. In that of the snail there is a very large one.

and the diameter of the two nucleoli plus the interspace was $\frac{1}{32000}$ inch. As the nucleoli were of equal size it follows that the diameter of the nucleolus could not be greater than $\frac{1}{64000}$; therefore, assuming that the interspace between the nucleoli was $\frac{1}{4}$ of the diameter of the nucleolus, it follows that the interspace was $\frac{1}{256000}$ inch, or ·0997μ.

It is quite impossible to say what is the thickness of the filament; it appears to be thicker than the flagella of the smallest bacteria, but not so thick as those of the larger forms. It is much finer than the barb on the spermatozoon of the newt which I discovered and exhibited here in 1882.

In the human spermatozoon I have seen as many as four nuclei in one spore. I have also observed many abnormal specimens, such as two heads on one tail; two tails on one head; two heads and two tails joined together like Siamese twins.

The following are measurements of an average spermatozoon:—

Head (spore and cup) long... ...	$\frac{1}{4250}$	5·9μ.
,, ,, broad... ...	$\frac{1}{7500}$	3·4μ.
Stem long	$\frac{1}{5700}$	4·4μ.
Tail (joint to lip)	$\frac{1}{500}$	·05mm.
Total (head, stem, and tail)... ...	$\frac{1}{425}$	·06mm.

Thus it will be seen that the spore and cup are $\frac{1}{10}$ of the total length of the spermatozoon. In conclusion I must plead my total inability to represent anything by freehand drawing, for the very indifferent picture I place before you. I trust, however, that with the assistance of the description, a more correct idea of this interesting object will be presented to your minds than that which has obtained hitherto.

Notes on Some Remarkable Coccids from British Guiana.

By S. J. McIntire.

(*Read October 26th,* 1888.)

In a recent letter from my friend, Mr. Robert Ward, of the Royal Botanic Gardens, George Town, British Guiana, the following passage occurs:—

"I am sending you in a small box, some scale-insects that attack our plants, especially orchids. Mr. Jenman (the head officer of the gardens) mentioned the other day, that he did not know the name, so I said I would send them to you, and he seemed pleased at the idea. If, therefore, it is not troubling you too much, we would be glad if you would find out all about them, and I will show Mr. Jenman what you have to say on the matter."

The tin box, containing leaves of orchids and of mango, duly arrived, and I was much struck with the extraordinary appearance of certain coccids upon the leaves. They resembled tiny tents pegged down, at six or seven points, to the surface of the leaves. They also, when viewed on the under surface, looked like tiny star-fishes. Altogether they were both curious and pretty objects.

At the first opportunity I took them to the Natural History Museum at South Kensington, but the officials, whose courteous attention I now deem it my duty to acknowledge, could not name the specimens. At the same time, however, they gave me the addresses of Mr. J. W. Douglas and Miss Ormerod, as possible sources from whence I might get the information I was in search of. Then they asked me to leave a specimen of the (to them) very remarkable coccid for the National Collection. This, of course, I promptly did, and delivered over my best mango leaf, with all the particulars on the subject which I could then furnish.

I wrote at once to Mr. Douglas, and by return of post he replied as follows:—

"I am much interested by and obliged to you for the speci-

mens of the coccid you have sent. Unfortunately all are more or less broken, but I recognize in them *Vinsonia pulchella*, Sign., described and figured by Signoret in the 'Annales de la Société Entomologique de France,' ser. 4, tom. x, p. 34, pl. viii, fig. 7 (1870). These are the only actual specimens I have seen, and if you have or can get any perfect examples I should be greatly obliged. Signoret had his examples on mango, from Reunion.

"On the orchid leaf you send is another kind of coccid, a flat, brown scale (sketch given), which also I should be glad to get more of if you have or can get."

In reply to this I sent him two more leaves, more carefully packed than on the first occasion. Next day he acknowledged my letter as follows:—

"I am very much obliged to you for the scales; those on the mango leaf are the most perfect. You are quite at liberty to do what you please with my letter. I gave the citation of Signoret's description and plate for you to send to your correspondent if you like. The examples received appear to be all female; the male is not known. It, like all coccidæ, would be a two-winged insect, very small, and is, perhaps, only to be obtained in its native country. The female is one of the most singular in form of all the coccidæ, although they exhibit the most wonderful variety. Signoret calls it 'cette magnifique espèce.' Ask your friend to send some of the flat scales, of which there was one on the orchid leaf you first sent; it may be *Lecanium acuminatum*, Sign. This is said to be transparent when alive, which I should like to have verified. When dead it becomes brown; at least, in the mature form. I think I have it thus on mango leaf from Ceylon."

Again I forwarded a couple more leaves, saying, as I did so, that one of the leaves seemed to display vestiges of other life upon it, and by next day I received a third letter as follows:—

"Many thanks for your further consignment of leaves. The oval scales (pale green, as I expected) are those of *Lecanium acuminatum*, Sign.; at least, that is my impression without minute investigation. The vestiges of 'other life' on the leaves are the remains of the male scales of an entirely different coccid —a *Diaspis*. That is all I can now say. Get your friend to send more of these or any other coccidæ on the plants—that is, on the leaves, etc."

Having, therefore, been successful in my inquiry, through the kind and courteous assistance of Mr. Douglas, a kindness much enhanced by the permission he gave me to utilize his intensely-interesting letters, I deemed it only proper I should furnish the Museum authorities with the fact I had gleaned, and I subjoin Mr. Waterhouse's letter confirming the accuracy of the opinion of Mr. Douglas :—

"I am much obliged to you for the name of the coccus. Your examples differ somewhat from Signoret's figure, but they may be referable to the same species for all that."

I am exhibiting the coccids in qnestion to the Club to-night, and will deposit them in our cabinet.

One slide shows *Vinsonia pulchella*, both dorsal and ventral aspect; another shows *Lecamium acuminatum;* and the third slide shows what appears to be the remains of an extraordinary colony of *Orthezias*, resembling the species recently brought forward at this Club by Mr. E. T. Browne (*Orthezia insignis*, Douglas), but much more minute, and, when alive, they must have presented a more remarkable appearance than that very curious and beautiful creature.

I shall duly press the request of Mr. Douglas upon my friend in British Guiana, and perhaps in the future we shall have the pleasure of more delightful letters from that gentleman, respecting further new creatnres that my friend may send to me.

Notes on Mounting the Diatomaceæ.

By H. Morland.

(*Read November 23rd,* 1888.)

As far as possible it is my intention in this paper to confine my remarks to the preparation of diatom slides and to the means as adopted by myself; I shall therefore have nothing to say about the preparation of the material, whether from recent gatherings or from fossil deposits, nor shall I have any remarks to offer about mounting in media of which I may only occasionally make use.

The media I usually employ are either air, Canada balsam, or the so-called styrax, and I mount my diatoms either "spread" or "selected."

Mounting slides of "spread" diatoms is simplicity itself, but, for all that, there are immense quantities of such slides prepared which are very far from being what they should be, the fault in no way lying with the cleaning of the material but in the way that the same has been mounted.

For instance, we will take a slide mounted "dry;" in many cases such a slide will be found to have either one or other of the following faults:—1stly. The diatoms have dried in ridges. 2ndly. The cell is so shallow that the slightest pressure on the thin cover-glass either crushes the diatoms between the same and the slip, or transfers it from the former to the latter, and 3rdly. If the slide be an old mount, in far too many cases the underside of the cover-glass is "dewed."

Now all and each of these faults are avoidable, and with very little trouble, nor is any particular skill required, though certainly a little judgment, easily acquired after but very short practice.

My method of preparing a "dry" mount is as follows:— First of all, I have ready prepared a number of slips with rings of either Bell's cement or Hollis's liquid glue (the former preferable, being cleaner) traced on them; these cement rings are

about $\frac{1}{8}$ inch wide, the internal diameter being $\frac{1}{8}$ inch smaller than the cover-glasses intended for same. I take care to have *plenty* of cement which can all be put on in one operation; I allow these rings to dry for a day or two, during which time the bulk of the solvent of the cement will evaporate, after which I harden these rings off thoroughly in a cool oven, when they are ready for future use. Secondly, I take care to have my diatom material in clean distilled water; if it has been put up in alcohol, the alcohol must be removed as far as possible and its place renewed with water. If diatoms be dried out of alcohol they will do so in a very irregular manner; they cannot, however, be preserved for any length of time in water, as fungoid growths will eventually appear and mat the diatoms together in lumps. Thirdly, I have a block of iron, three inches square and two inches thick; this I heat on a kitchen range and place on some old book or other, making use of it as a "hot table." Its advantages are that it is steady and that the heat can be so well regulated, such heat being retained for some little time; of course, the larger the block, the longer will the heat remain fairly constant. Having one or more clean cover-glasses and everything else ready, I now commence operations by shaking up my tube of cleaned material and, before the diatoms can settle down again, taking some of the same up in a pipette, the end of which has been drawn down so that the aperture does not exceed $\frac{1}{16}$ inch diameter at most, and placing a drop of my material on each of my cover-glasses; if necessary, this drop can be spread over the whole surface of cover-glass either by breathing upon it or by means of a hair or bristle, but if the latter plan be adopted it is as well to shake the cover-glass sideways a little and let the diatoms settle evenly. If the diatoms be large a *little* heat may be applied to dry off the water, but if small, no heat whatever must be used as otherwise the diatoms will certainly dry in lines and ridges. When the diatoms are dry all that is now necessary to finish the mount is to place the cover-glass on the hot block, turn a "ringed" slip over and press the same down on to the cover, taking care that the ring and cover centre each other. The heat of the hot block will soften the cement and cause the cover to adhere to the same; the slip, being transparent, allows one to see exactly what is going on underneath,

as it will not do to press down more than necessary to cause adhesion all round for fear of crushing the diatoms between the slip and cover. It is as well not to make the iron block too hot for fear of over-softening the cement ring. With the addition of a label the slide is now, for all practical purposes, complete, but, if it be desired to put any ornamental ring round the cover-glass, no cement must be used the solvent of which will in any way soften or dissolve the original ring under the edges of the cover-glass, as in such case "dewing" would infallibly eventually appear on the underside of cover-glass, as such solvent would gradually work its way inwards through the hard cement and reappear as "dewing," which even in small quantity is a decided blemish in a "dry" mount.

In mounting "spread" diatoms in balsam or styrax (both of which media I prefer being dissolved or thinned with benzole to any other solvent) I prepare my cover-glasses as for "dry" mounts, and, placing a sufficient quantity of my medium on the centre of a slip, I invert my slip over the cover-glass, picking it up and immediately turning the slip over again when the medium gradually spreads to the edges of the cover-glass, if not, it is either because the balsam or styrax is too thick or in insufficient quantity. If the former, the minutest drop of benzole at the edge of the cover will rectify matters, but if the latter, more balsam or styrax must be added. A little judgment and practice is necessary to determine how much of the medium is required. If the slide be now placed under the microscope, in all probability a number of minute bubbles will be observed under the cover. These will gradually disappear, and it is as well to let the balsam slides remain as they are for a few hours. The balsam or styrax can be hardened off by placing the slides in a cool oven or other warm place for several days, care being taken that the heat is never great enough to cause the reappearance of bubbles under the cover. The difference in mounting with styrax or with balsam is that I use no heat whatever when using the latter, nor do I do so until after *all* bubbles have spontaneously disappeared; but with respect to styrax, I do my mounting entirely on the hot block, first driving away all the benzole from the styrax and then, after the cover-glass has been placed in position, placing the slide on the hot block to get rid of any bubbles

that may have formed under the cover-glass. I may here say that, when once the benzole has been driven off, styrax mounts can stand, and really require a considerable amount of long-continued heat to harden them off properly, and, unless these mounts are over-heated, the styrax never really becomes hard, but only tough, so that I make it a rule to finish off all my styrax mounts with a ring of either Bell's cement or Hollis's liquid glue.

I fancy I can hear many exclaim, "Why, what is this? There is no occasion for this length of time over a balsam mount. I can finish one off in an hour, or even less." Perhaps so, but will such a person guarantee perfect mounts—no bubbles in frustules or near the edges of cover-glass? Besides which, if the medium be boiled even in the slightest degree it will follow as a matter of course that a larger number of diatoms will be detached from the underside of cover-glass than if no boiling whatever had taken place, and I think that all will allow that it is desirable to have as many diatoms on the cover-glass as possible, especially when we come to examine such slides under a short distance working object-glass. It is advisable to have sufficient of the medium under the cover-glass lest the same should sink down too low and crush the diatoms under it; if, therefore, to avoid this mishap a little too much balsam be used, it may happen that when a diatom falls away from the cover-glass down on to the slip beneath, the same may be beyond the focus of a high power objective. But granted even that the objective has sufficient working distance to examine down to the surface of the slip, it is still advisable that by far the greater majority of the diatoms should be on one focal plane, as otherwise the constant focusing up and down, whilst looking over a "spread" slide, will be found to be very trying to the eyes. Moreover, with every care, some of the smaller diatoms can be easily overlooked, even when immediately under the objective, in consequence of being either within or without the focus of same.

I will now proceed to the description of how I mount "selected" slides, but before doing so I wish to say that I can give no certain and sure method of preparing such slides, by this I mean slides that can be placed under a $\frac{1}{12}$ inch objective without flinching, as such high powers will only too often show

up defects in the way of dirt, or else the fixing cement by which the diatoms are attached to the cover-glass becomes distinctly apparent. However, as, on the other hand, my efforts are often crowned with success, I venture to now describe the plans which I adopt.

First and foremost as a very material aid to success it is absolutely necessary to select and mount the diatoms under a fairly good magnification, as otherwise one can only guess at what he is doing, whereas absolute knowledge is required. The power I employ is one of 60 diameters. I use a Stephenson's binocular, which has the advantage not only of erecting the image, but also of a large horizontal stage. To the tube of this microscope I attach in front a piece of $\frac{1}{4}$in. glass tubing, about four inches long, so arranged and bent that the lower end points immediately under the objective I am using, but not projecting far enough to be seen when I look through the microscope. On the other end of this tube I fix a piece of india-rubber tubing, with a glass mouthpiece, which I bring over the front of my microscope between the eye-pieces and allow to hang down behind; this is my "breathing-tube," the use of which I will explain later on. This breathing tube being fixed to the tube of the microscope works up and down with it when the latter is being focused, and always has the same relative position with the objective after it is once fixed in its place, but can be turned away on one side if desired. Should this tube at any time get very wet internally through being used, it can soon be dried again by simply drawing the breath through it for a short time.

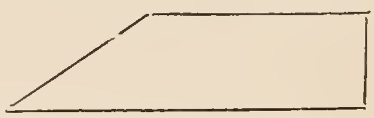
My mounted bristles take next rank; of these I have some seven or eight always by me of various degrees of fineness and in duplicate for fear of accidents whilst mounting. It is very important to have good bristles, and I was a long time before I could get exactly what I wanted; the attributes of a good bristle are that it should be fairly stiff and taper suddenly to a very fine point. I obtain mine from a certain clothes brush which I have at home, examining it carefully under a Coddington and selecting those bristles which meet my requirements. I then mount them in slender handles in a cleft (so that they can be placed centrally) and afterwards whip round with thread, varnishing the same over with liquid marine glue. I have heard a good deal about split bristles from shaving-brushes, but could

never make anything of them, nor do I know they were ever used, excepting on paper; but under any circumstances I maintain there is not the slightest necessity for such bristles, as I will undertake to pick up and transfer the largest or smallest diatom (capable of being handled) by means of one of the bristles I regularly employ.

Another important piece of apparatus is my "mounting slip," which I prepare as follows:—First I take care to select if possible a flat $3'' \times 1''$ slip, as many slips are curved more or less, but should there be the slightest curvature I arrange for the hollow side being underneath. On the upper surface at one end I attach an ordinary slide label and put the slide on one of the late Dr. Matthews' turn-tables, taking note of the position of the labelled end, as these turn-tables are not always absolutely central with the slides, and the "mounting slip" whenever put on the turn-table at future times, must always be placed as in the very first instance to ensure correct centring. I now mark on the centre of the slip a series of four concentric rings, the smallest being about $\frac{1}{10}$ inch across, the next one $\frac{1}{5}$ inch, the third $\frac{3}{10}$ inch, and, finally, the fourth one $\frac{2}{5}$ of an inch in diameter. These dimensions are only approximate, a little larger or a little smaller being quite immaterial. These rings are drawn with a mixture of a little aniline, dissolved in gum, and are for the purpose of enabling one to rapidly centre the slide when under the mounting microscope. Over these rings, with the smallest amount of balsam possible, I place a $\frac{7}{16}$ inch covering-glass, on the *upper* surface of which are ruled two series of lines, $\frac{1}{250}$ inch apart, and crossing each other at right angles. These lines cover a surface of about $\frac{1}{4}$ inch square, and are for the purpose of guidance when arranging diatoms on a cover-glass; they are useful for enabling diatoms to be set square with each other and at definite distances apart.

The only other *special* tools which I have to describe are, firstly, a piece of glass tubing, about $\frac{1}{4}$ inch bore and two inches long, with one end opened out slightly, something like a tobacco-pipe mouthpiece; this I use for breathing on my glass covers in order to attach them to my "mounting slip." Secondly, two pieces of brass, one $\frac{5}{16}$ inch diameter and $\frac{1}{10}$ inch thick, the other, one inch long, $\frac{3}{4}$ inch broad, and $\frac{1}{8}$ inch thick. On the

smaller of these pieces of brass I place my cover-glass with my arranged diatoms and pick the same up again with a drop of balsam or styrax placed on the centre of a slip, said slip being turned over the prepared cover-glass and centred, centre to centre; one end of the slip resting on the larger of the pieces of brass, which is simply for the purpose of steadying the slip and keeping it fairly square and level with the cover on the smaller piece. It will be noted that the larger piece is slightly thicker than the smaller, which is to allow for the additional thickness of the cover-glass. Thirdly and lastly, I have a 3″ × 1″ glass slip, with one of the angles cut off and the small end rounded off at a grindstone, thus:—



This slip is only for use when one has to deal with material containing a quantity of very fine sand. By placing two or three drops of water containing such material on the centre of this slip and then tilting the whole off again rapidly past the pointed end on to an ordinary slip or cover, the bulk of the sand, with very few diatoms, will be left behind on the pointed slip. A very few trials will enable anyone to acquire the knack required.

I have two methods of preparing slides of "selected" diatoms, one where the diatoms are in no way fixed with gum or other cement, the other where I use gum for this purpose.

Proceeding to describe my first method, I may say that this plan will only answer for the finer and flatter diatoms, and success is more certain if styrax be used instead of balsam. It is, to say the least, a very risky plan, as the diatoms are very apt to get displaced even after the slides have been finished off for some time, but, on the other hand, the requisite knack is easily acquired, and when the mount is successful the result is simply perfection; such a mount can fearlessly be placed under the very highest powers.

To begin, I first allow a drop of water containing my material to evaporate on an ordinary 3″ × 1″ slip, taking care that the diatoms are not too crowded together; from the dried material I select my diatoms under the microscope by means of one of my "mounting bristles;" these I place just outside the outer edge of the dried material for use as required, as I make it a rule never to select my diatoms on the days that I mount them, though occasionally this rule is broken. Having a number of

diatoms selected and put on one side I set a day apart for mounting them. (I may here say that I invariably mount by daylight, as I think it is less trying to the eyes than lamp-light, more especially when persevered in for some hours together.) I begin by first transferring as many of the diatoms as I may require on to my "mounting slip," placing them about half-an-inch to one side of my ruled-glass disk in an inked square or circle so that they can be readily found when wanted. I now attach a cleaned cover-glass to the upper surface of the ruled-glass circle; this I do by breathing on it through the short piece of glass tubing already described. Note that I breathe on the cover I intend using, and *not* on the ruled circle on my "mounting slip." On turning the cover over and pressing it down on the ruled glass on slip it will adhere sufficiently firmly and long for all practical purposes. Placing my slip under my microscope I now take up the "selected" diatoms one by one and arrange them on the cover-glass as desired. It is, however, sometimes needful to pass these diatoms through a drop of water under the microscope in order to free them from dirt or particles of broken diatoms.

When arranging the diatoms care must be taken that if the diatoms have a concave side the same be not placed next the cover-glass, as in such case a bubble would be formed there when the styrax was applied, with the result that the diatom would inevitably be dislodged. When the diatoms are arranged satisfactorily all that is now necessary to fix them is simply to breathe upon them gently through the "breathing tube," watching them through the microscope at the same time. The moisture of the breath is condensed on the cover-glass and causes the diatoms to adhere closely to the same; the breathing must not be continued too long, as otherwise the excess of condensed moisture will very often cause the diatoms to float and get displaced. The moisture can easily be dried up again by simply drawing the breath through the tube. The "mounting slip" is now placed on the turntable and carefully centred, when a small "guide ring," about $\frac{1}{10}$ inch in diameter, can be traced round the arranged diatoms with a mixture of gum and some colouring matter, such as lamp-black, which is not apt to fade as do the aniline colours. The slip intended for use with the cover can also be ringed now on the *under* side, as this ring

will be useful for centering the slip with cover, and can afterwards be rubbed off again; note any curvature of slip, always having the concave side for the under side. The next thing required is to have the iron block, already described, duly heated, and on this I place my two small pieces of brass about one inch apart; on the smaller I place the prepared cover, which I slide off the ruled disk on "mounting slip" by means of a piece of wood, as metal would injure the fine rulings. A drop of styrax is now placed on the centre of the slip (on which the small circle has been traced on the under side) and the slip put on the hot block to drive away all trace of benzole. Whilst the

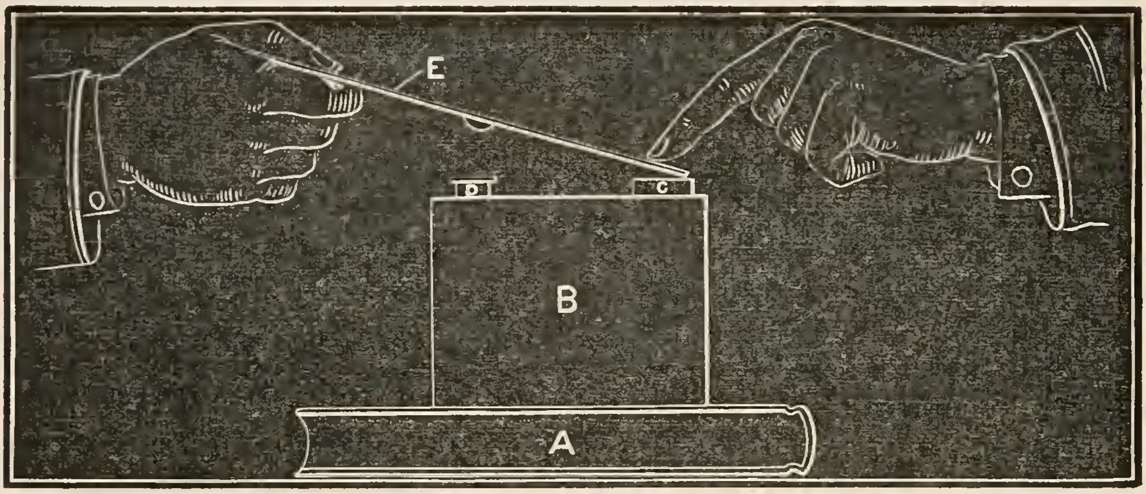


Fig. 8.—A. Old book for preventing injury to table from hot block. B. Iron block, 3″ square and 2″ thick. C. Piece of brass, $1'' \times \frac{3}{4}'' \times \frac{1}{8}''$ thick. D. Piece of brass, $\frac{5}{16}''$ diameter $\times \frac{1}{10}''$ thick, with prepared cover-glass on top. E. An ordinary $3'' \times 1''$ glass slip turned over, with drop of balsam or styrax underneath.

By pressing the slip E with the fingers of the left hand down on to the piece of brass, C, whilst resisting slightly upwards with the right hand, the slip can be lowered very steadily and accurately over the prepared cover on piece of brass, D, without danger of crushing the arranged diatoms.

Note.—If the iron block, B, has been heated for *styrax* mounting, it will be necessary to have a small slip of wood, or other non-conductor of heat, under the fingers of the left hand to prevent them from being burnt.

slip is still hot it is turned over the prepared cover, as in Fig. 10, duly centred with the cover and lowered carefully and gently until the styrax is just in contact, when, if the heat is just right (only found out by practice, but somewhere about 180° Fahr.), the styrax will at once spread to the edge of the cover, and the whole can be turned over again with the cover uppermost; if all be well the diatoms will not have shifted, though when the slide comes to be examined under the microscope a few bubbles may possibly be found. To get rid of these all that is necessary is simply to let

the slip remain a short time on the hot block, when they will gradually disappear. The iron block must be placed level, as otherwise the cover-glass is apt to slide on one side when the styrax softens under the heat. When once the cover-glass is in position it must never be moved nor touched until after the styrax has been hardened off, for fear of displacing the arranged diatoms. These slides are hardened and finished off in the same manner as described for "spread" slides. Should it be determined to employ balsam instead of styrax, the same will have to be applied cold, and not hot, as with styrax, because a thin skin or pellicle forms on the surface of the balsam, which skin is almost certain to displace the diatoms in the final act of mounting. In using balsam to "arranged" diatoms without fixing cement it would be as well to use the pure, natural balsam thinned down with benzole, and not the baked balsam similarly thinned down, as this latter kind rapidly forms a pellicle on exposure to the atmosphere.

Should the "selected" diatoms be large and heavy, or strongly hollowed out, or beset with spines or processes, it is then necessary that they be fixed down onto the cover-glass with gum or other cement, as otherwise they would be certain to get displaced when the balsam was applied. I never use styrax to diatoms which have been fixed with gum, etc., as not only would the gum be almost certain to be apparent, but because the styrax runs out at the edges to a considerable extent when heated under small covers, such as I generally use, thereby allowing the cover to sink down so close to the slip as to endanger the safety of the diatoms between them. Personally, I fix my diatoms with gum, because I can do this under the microscope and watch the process, which with me is very similar to the method I have just described, the only differences being as follows:—In the first place, I apply the minutest drop of gum arabic dissolved in water, by means of a glass rod, onto the centre of my cover-glass, after the same has been fixed on the ruled disk of the "mounting slip" by means of the breath, as already described; this drop of gum is allowed to dry, and is then examined under the microscope. Any specks of dirt or fibres in the gum can now be removed by means of a stiff mounted bristle, on the gum being softened by being breathed upon through the "breathing tube." It is also as well to shade

off the edges of the drop of gum by strongly moistening it by the breath and mixing the edge with the moisture by means of the stiff bristle; the gum can be rapidly dried again by drawing the breath through the "breathing tube." The diatoms are arranged on this gum in the manner desired, and afterwards fixed by breathing gently through the tube whilst being observed through the microscope, for fear of carrying on this fixing process too far. In the second place, the balsam is applied cold, and if the diatoms stand up rather high it may be necessary to apply a fairish quantity of the balsam, which, in such case, must not be too fluid or it will run out at the edges. Practice is the best guide in this matter.

My objection to using gum or other fixing cement is that in far too great a proportion of cases the same is visible more or less where it gets hold of the diatoms; for instance, there may be seven or eight diatoms in position, all of which, with the exception of one, being perfect, but the remaining one is spoilt by the gum showing up on it. As far as I can see there is no certain way of avoiding this difficulty, but it is amenable to judgment in some few cases. I try to avoid it as far as possible by breathing as little as I can venture, with the result that one or more of the diatoms may float away on the application of the balsam. On the other hand, some diatoms can be fixed down with impunity, such as some of the Aulacodisci, Trinacriæ, etc., with prominent processes upon which they stand and are fixed down, the body of the valve being quite clear of the gum. Some valves with very fine cellular structure sometimes get some of the cells clogged up with the gum, retaining air in them which cannot get displaced by the balsam in consequence of the insolubility of the gum in the solvent of the balsam. I have heard of a thin solution of caoutchouc in benzole being employed as a fixing cement, but I have never tried it; with this cement, after the diatoms have been arranged, they are fixed down by means of a gentle heat. Now, as caoutchouc is slowly soluble in benzole, it has struck me that any imprisoned air might be gradually liberated by the solvent action of the benzole in the balsam, whilst the diatoms might still be retained in their places by the stickiness of the caoutchouc under these circumstances; at least long enough for the balsam to get properly hardened in the cool oven. I merely throw this

out as a suggestion; my objection to this plan is that I would be unable to observe the process of fixing down under the microscope.

I have occasionally exhibited slides at this Club with one of the diatoms, a very thin one, standing on its edge and perfectly perpendicular. Now this must appear to many to be extremely difficult of accomplishment, and many may wonder how it is done. The task is not so difficult as it may at first sight appear; the diatom "on edge" is the first one put into position; it is by no means difficult to get such a diatom set up on edge *somewhere* near the centre of the cover-glass, but it would be difficult to place it in a certain exact spot, though even this could be done by repeated trials. However, the diatom having been placed on its edge somewhere near the desired spot, the same is now fixed by breathing very, very gently through the "breathing tube" with the mouth open. As soon as it is seen that the diatom has got fixed to the cover-glass it must be noted if it be perpendicular or not, if not, it can be set up properly by turning the leaning side towards the end of the "breathing tube" and blowing it over gently, the breath softening the gum to the necessary pitch. In such a slide only *one* diatom is fixed up "on edge," the remaining valves being afterwards added, laid flat.

In drying cleaned material on a glass slip, it will often be found that the surface of the glass appears as if it were greasy, causing the water to run up into very irregular shapes with the diatoms all in patches. This is very annoying when diatoms are particularly wanted to be spread as evenly as possible, but the difficulty is easily overcome; all that is necessary is to take a drop or two of clean water and a clean cloth and rub the surface of the slip, but not *quite* dry, the residue of moisture being allowed to evaporate spontaneously; if properly carried out this plan will now allow the water with cleaned material to lie on it in any manner desired. Should the cloth leave any fibres behind they must be removed with a camel-hair pencil. The slip must not be rubbed again with the cloth when once it has dried, as it is the *dry* cloth which seems to impart the greasiness to the surface of the glass.

Although I have mounted diatoms for some time past, I don't find that I can now prepare them any the quicker, the fact

being that I am more exacting than I used to be. My object is not now to fill my cabinet, but simply to get perfect slides if possible, and this cannot be done unless care be exercised. I am by no means infatuated over slides containing scores of diatoms, but comparatively few species, many of the valves being found to be dirty and clogged when examined under a moderately high power, say a $\frac{1}{4}$-inch, and the whole pattern of which can only be seen under a very low power, a 2-inch or 3-inch, quite unsuitable for examining the diatoms themselves. Moreover, there is no special difficulty in mounting such slides, for if any-one can arrange a dozen diatoms properly, there is no limit to the number he can so arrange, it being merely a question of time, without, to my mind, a corresponding compensation.

I have endeavoured, as far as possible, to shorten this paper without sacrifice of utility. Many of the minutiæ I have described may seem of but small moment, but neglect them, and the difference will be that between a good mount and a very imperfect one. Haste is far too often the cause of failure, but when our work has to be, as it were, superhypercritically examined under high power objectives with high numerical apertures, it behoves us to do our very very best, so that our work may come out scathless through the ordeal.

On Perophora Listeri, an Ascidian found at Totland Bay, Isle of Wight.

By Charles Rousselet, F.R.M.S.

(*Read November* 23*rd*, 1888.)

Plate XXV.

About the beginning of October, at the invitation of a friend, I spent a few days at Totland Bay, in the Isle of Wight, and in searching over the sea-weeds in the Bay at low tide, we found some minute clusters of white jelly, which I did not remember to have seen before. On placing a small piece of it under the microscope at home I saw at once I had found a beautiful Ascidian, whose name was soon ascertained to be Lister's Perophora. The perfect transparency of the test enabled me to study and understand the structure of this class of animals much better than before by the mere reading of descriptions in books.

I brought several clusters with me to London, and although I kept them in only a few ounces of sea-water, they remained alive and in perfect condition for three weeks, and I exhibited some at the Conversational Meeting of the Club on the 12th of October. They also budded freely until a few days before our meeting last month, when they suddenly died down, apparently from the cold weather, which had then set in. I have mounted a group in glycerine, which shows the structure very well, and which is shown in the room under my microscope.

I gave a branch of it to Mr. Waddington, in whose aquarium they have revived again, so that I am enabled to exhibit some living specimens also. Mine are not dead; numerous buds have been produced showing the pulsating heart, but they do not attain maturity.

As this pretty Ascidian affords such a good opportunity of becoming acquainted with the structure of the class, I have thought a few remarks on its anatomy would not be out of

place, although, of course, its structure is perfectly well known, and I have nothing to add that is new.

Mr. Michael some years ago read before you a paper "On the Larva of an Ascidian found at the Land's End,"* illustrating it with some slides he had mounted of the embryo in various stages. He then gave you an interesting account of the tadpole-like, free-swimming stage through which most of the young Ascidians pass, and of their supposed affinity to the vertebrated animals, on account of the formation of a primitive neural canal, and of a rod-like body in the tail, which is held by eminent zoologists to correspond to the notochord of the vertebrata, and, if true, would raise the tunicates from the mollusca, to which they have previously been classed, to the lowest representative of the vertebrata.

I will not, however, discuss this subject, but only draw your attention to the interest that is attached to the Ascidian as a class, and will confine my remarks to a short description of the specimen before you.

Perophora, first discovered by Mr. Lister, is one of the "Social" Tunicates as distinguished from those that are "simple" on the one hand, and those that live aggregated together under the same tunic, and are called "compound."

It is found growing on sea-weeds, not unlike some of the hydroid Zoophytes. It can easily be seen as a cluster of minute globules of jelly, each separate on a peduncle, but all organically connected together by a creeping stalk or stolon. In size the individuals average $\frac{1}{16}$ inch, and when clean their test is so transparent that all the organs can be seen, and the structure studied with the greatest ease under the microscope.

The test or tunic is nearly square in shape, with two large apertures situated close to one another at the free extremity. One of these is the oral aperture, or mouth, leading into the branchial sac and alimentary canal, whilst the other is the anal funnel. The test is leathery in consistency, and remarkable as being one of the few animal structures containing cellulose.

Below the test there is another membrane, the second tunic, or mantle, only loosely connected with the first, which is mainly composed of longitudinal and transverse muscular fibres, by means of which the animal can contract with considerable

* "Journ. Q.M.C.," Ser. II, Vol. 2, p. 111.

force, and eject water from its oral and anal orifices. Within this second tunic there is also seen an extensive network of blood sinuses, through which the blood circulates freely.

The oral or ingestive aperture leads into a wide chamber known as the branchial sac, which fills nearly the whole of the test. Its walls are perforated by four rows of minute elongated slits fringed with cilia, and by the action of these cilia a current of water is produced which enters the oral aperture, passes through the openings in the wall of the sac, and out at the anal orifice. The walls of the branchial sac are strengthened by minute rod-like thickenings of the integument, lying at right angles to each other, and these contain hollow spaces through which the blood circulates, and by means of the constant flow of water over them the blood becomes aerated. Thus the function of the sac is clearly seen to be respiratory.

On the other hand the branchial sac is nothing else but the anterior part of the alimentary canal, and therefore corresponds to the pharynx of other animals; and in being perforated and subserving the function of respiration it is unlike the corresponding organ in the invertebrata, but analogous to the perforated pharynx of Amphioxus and the lower fishes.

At the bottom of the branchial sac there is an opening which leads by a short œsophagus into the stomach, from which an intestine is continued in an S-shaped curve. It lies at the side of the branchial sac, and ends in an anus, which, however, does not communicate directly outwards, but opens in the middle of the atrial chamber.

The branchial sac is only connected along one side (the hæmal side) and around the mouth with the test and mantle; it otherwise lies quite free within the tunic, a few pillars of muscular or connective tissue only serving to keep it in place. A wide space is thus left nearly all round, which is known as the atrium or atrial chamber, and it is with this chamber that the excretory or anal aperture of the test communicates.

The atrium, according to Professor Huxley, is lined by a membrane which is reflected like a serous sac on the pharynx and viscera, and constitutes a third tunic or peritoneum. It enters into close union with the proper wall of the pharynx, and is perforated with it by the ciliated slits.

If this be correct, it will be observed that the branchial sac,

stomach, and intestine lie properly outside the peritoneum and body cavity of the animal, just as the alimentary canal of vertebrates is suspended in a fold of the peritoneum, but lies outside of it.

At the posterior part of the body, and opposite the excretory aperture is situated the heart, which is an elongated sac without valves, open at both ends, and contracting with a spiral motion. The blood, consisting of a clear fluid with numerous colourless corpuscles, is driven through the blood-channels and spaces between the tissues, the animal having no proper vessels with walls of their own; two main sinuses are situated on opposite sides of the pharynx. The heart, which is enclosed in a pericardium, has this strange peculiarity, that after pulsating a few minutes and propelling the blood in one direction, it stops, and then reverses the action, and the blood flows in the opposite direction. The creeping stalk connecting the various individuals of a group contains two distinct canals, which send branches in each peduncle, and are connected with the heart and circulatory system respectively of each animal, so that the blood of each colony is common property, and circulates through all the members; yet when one individual is detached by its peduncle it does not die; the severed canals close up, and the returning current of blood quickly finds its way back into the heart, thus showing that each member is quite independent of the others.

The circulation of the blood through the heart and throughout the body can be seen to perfection in this species, and can be watched with the microscope under considerable amplification.

The nervous system consists of a single ganglion—all that remains from the elongated neural cord of the embryo—placed near the mouth between the two apertures of the body. It can best be seen when looking through the oral orifice in a favourable position of the animal. The endostyle is a rod-like body lying on the hæmal or ventral side of the branchial sac. In Prof. Huxley's words, "It is a longitudinal fold or diverticulum of the middle of the hæmal wall of the pharynx, which projects as a vertical ridge into the hæmal sinus, but remains in free communication with the pharynx by a cleft upon its neural side." The real nature and function of this structure, which is

present in all Ascidians, appears to be very little understood. It can, however, well be seen in Perophora.

In two individuals I observed a spherical cellular structure with a dark mass in the centre, situated at the anterior end of the endostyle, in the angle formed by two ciliated arcs which surround the oral aperture, and pass, just above the ganglion, over a small cone projecting into the pharyngeal cavity. In the other members of the colony this structure was absent, and I am unable to indicate its nature. An auditory capsule has been described as situated on the ganglion. The animal has no other sense organs, no appendages, and no limbs. It is permanently fixed, and the only movement it is capable of is a slight contraction of the mantle, and the closing of its two apertures. The branchial sac does not contract, and the cilia of the stigmata are seen to be driven through the slits by every contraction of the mantle, giving the appearance of so many minute shutters being closed simultaneously.

The mouth is guarded inside, and a little below its opening, by a circle of small non-ciliated tentacles, which stretch across the aperture to keep out, no doubt, unbidden guests. With the current of water entering the mouth, small animals, such as infusoria, Cyclops, larval crustaceans, etc., are taken into the branchial chamber, and being unable to escape through the minute slits, they pass down to the corner where the opening of the œsophagus is situated, through which they are soon forced into the stomach. The animal, however, has no hard or horny part there, nor anything resembling teeth for seizing or tearing the food.

The lower end of the intestine is surrounded by a loose tissue of spherical cells, out of which a fine duct can be seen to emerge, terminating in that part of the intestine which lies immediately behind the stomach. This structure is no doubt hepatic in function, and the duct is the bile duct.

Nearly all tunicates are hermaphrodite, and the reproductive organs are stated to be situated in a fold of the intestine. I have been unable to find them in Perophora, nor have I seen any indication of embryos or larval forms in the atrial chamber. Perhaps the season of the year is not favourable for their production. The only mode of reproduction I have witnessed is

their growth by gemmation on the creeping stem, similar to the budding of fresh-water polyzoa.

I have noticed that when an old animal dies a new bud is frequently formed inside the old tunic, which forms a ready-made house to the growing bud.

I trust that these few notes will enable those not already acquainted with this interesting group of animals, to better understand their structure when examining the living examples commonly found everywhere on our coast, but if they are fortunate enough to come across the somewhat rare species described in this paper, I think they will agree with me, that there are few more beautiful sights in microscopical life than is *Perophora Listeri*.

EXPLANATION OF PLATE XXV.

Fig. 1. *Perophora Listeri*, a single animal on its peduncle, side view, × 30.

,, 2. The same, front view, looking down upon the oral orifice, and showing the branchial sac suspended freely in the atrial chamber, being attached to the tunic only on the ventral side and around the mouth.

,, 3. Group of *Perophora* × 6.

,, 4. Diagrammatic transverse section through *Perophora*. *aa.* Atrial chamber. *cc.* Cavity of branchial sac. *tt.* Test or 1st tunic. *mm.* Mantle or 2nd tunic. *pp.* Peritoneum or 3rd tunic. *bb.* Proper wall of perforated branchial sac. *e.* Endostyle.

C. Rousselet ad nat del.

West Newman & Co lith.

Note on a New Rotifer, "Limnias Cornuella."

By Charles Rousselet, F.R.M.S.

(*Read December 28th*, 1888.)

Plate XXIV.

On one of my visits to my favourite hunting ground, the Gardens of the Royal Botanic Society in Regent's Park, on the 21st November last, I came across a Limnias attached to the rootlets of a plant (*Trianæ Bogotensis*) growing on the surface of one of the hot-house tanks, which appears to be undescribed and new to science.

Its aspect as a whole is very striking, and differs markedly from the two known species of the genus, viz., *Limnias Ceratophylli* and *L. Annulatus.* I happened to have both these in my aquarium at the time, so that I was able to compare them with my specimen.

I have named the new species *Limnias Cornuella* on account of the shape of the tube, which looks very much like a "little horn."

The accompanying figures will give a good idea of the general appearance, and the following is a description of its principal characters.

The tube is much smaller than in the two other species, being only about half the size. It is white, glassy transparent at both extremities, but in the middle rendered more or less opaque by a granular deposit, and ringed like the tube of *L. annulatus*, but not quite so distinctly. The tube is always gracefully curved or twisted, very rarely, if ever, straight, widening very gradually from the point of attachment to the mouth. It consists of a thin, tough, horny material, and can be pressed quite flat without breaking.

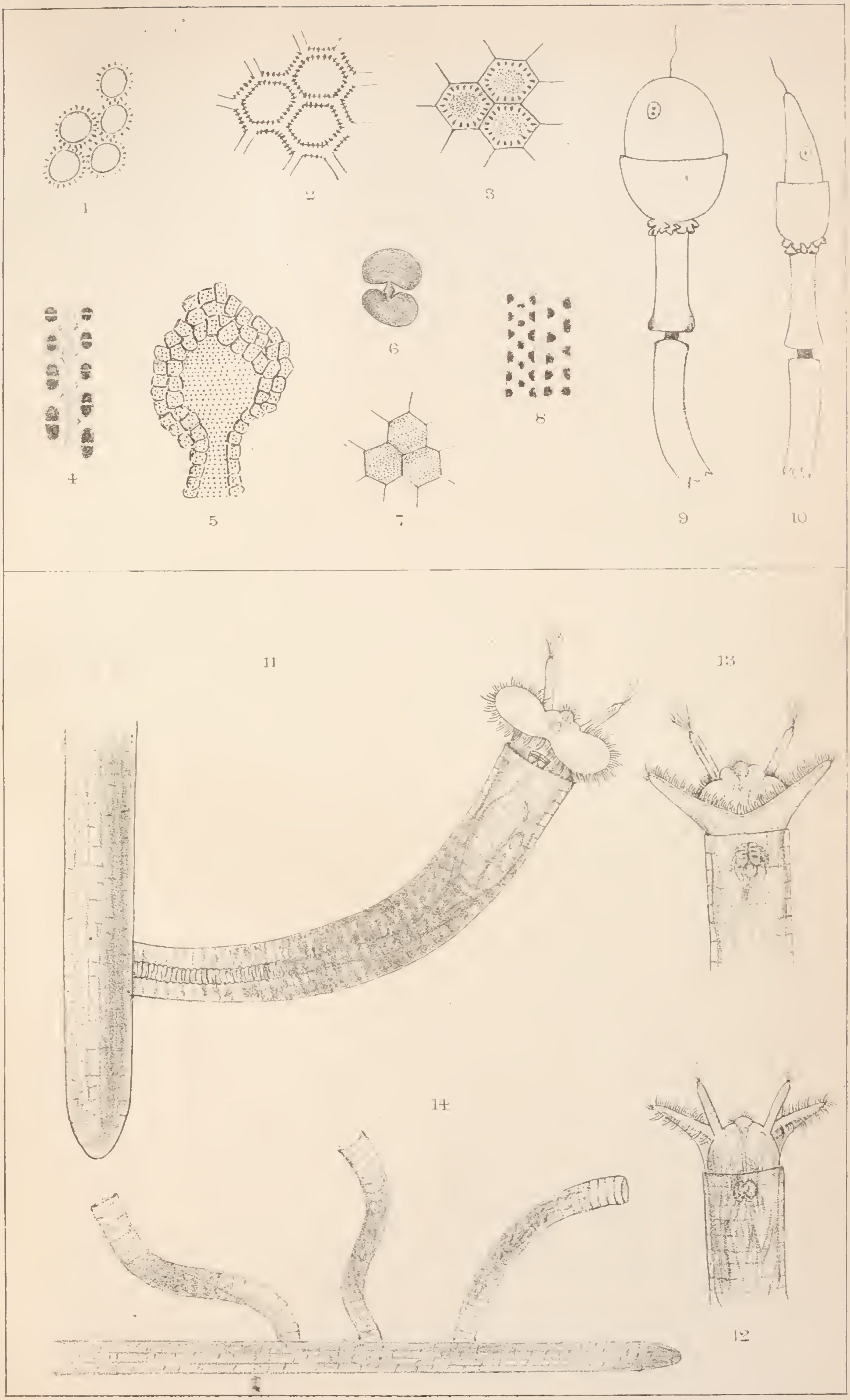
The most striking character of the animal is its two long ventral antennæ, surmounted by tufts of long setæ. In *L. ceratophylli* the antennæ are hardly visible; in *L. annulatus* they are short and stumpy, but in the present species they are nearly

three times as long, non-retractile, and always standing out prominently and projecting beyond the disc. The ciliary disc is two-lobed, and when expanded it generally lies in a plain at right angles to the tube, not parallel with it, as is the case in the two other species. The animal does not protrude far out of his tube. It has a prominent ciliated chin, and two pairs of minute horny processes are seen on the dorsal side of the head.

The mastax and internal organization are normal as far as I have been able to see, but the rotifer is rather opaque, and it is difficult to make out much of the structure. Size of tube, $\frac{1}{60}$th to $\frac{1}{50}$th inch.

EXPLANATION OF PLATE XXIV.

Fig. 11. *Limnias cornuella* expanded; view from dorsal side × 180.
,, 12. Head of same, ventral aspect × 200.
,, 13. ,, ,, dorsal aspect × 200.
,, 14. Various forms of tubes × 60.



C. Rousselet ad viv. del

West, Newman & Co. lith.

PROCEEDINGS.

June 8th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Section of human spinal cord	Mr. F. W. Andrew.
Cyclosis in *Nitella*...	Mr. E. K. Jaques.
Antheridium of *Nitella*, showing antherozoids, *in situ*	Mr. G. E. Mainland.
Various Rotifera	Mr. C. Rousselet.
Ringworm hair, with fungus, *Tricophyton tonsurans*...	Mr. H. M. Simmonds.
Pleurosigma angulatum, with dry $\frac{1}{6}$ object-glass	Mr. T. F. Smith.
Coscinodiscus, sp., with $\frac{1}{12}$ oil imm. „ „	„ „

Attendance—Members, 34 ; Visitors, 7.

June 22nd, 1888.—Ordinary Meeting.

B. T. Lowne, Esq., F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The Rev. Chas. C. Collins was balloted for and duly elected a member of the Club.

The following additions to the Library and Cabinet were announced :—

"Proceedings of the Hertfordshire Natural History Society"	From the Society.
"The American Monthly Microscopical Journal"	In exchange.
"The Scientific Inquirer"	„
"Proceedings of the Royal Society"	„
"Journal of the Royal Microscopical Society"...	„
"The Botanical Gazette"	„
"Grevillea"...	Purchased.
"Annals of Natural History"	„
"Quarterly Journal of Microscopical Science"...	„
"Science Gossip"	From the Publisher.
Three Slides—stained leaves	Mr F. H. P. Hind.

The thanks of the meeting were voted to the donors.

Mr. Robinson read a paper "On Encysted Diatoms," illustrating the subject by a diagram and by specimens exhibited in the room.

Mr. Karop thought it would be necessary to know some further particulars before saying much about these specimens; for instance—In what condition were these diatoms when found? Was the endochrome perfect? because it was not an uncommon thing for diatoms to get enclosed in other organisms which devoured them, such as *Vampyrella Vorax*, which had a habit of so doing. If this sort of thing took place the endochrome cells would break up. Then it might be noted that many forms, such as *Synedra*, sprang from a gelatinous mass, in which it was quite possible for other forms to get enclosed. He thought, therefore, that this was probably a case either of parasitism or of enclosure in the gelatinous portion of another form, and not what was generally known as encystment.

Mr. Robinson, in reply to a question, said that he had not noticed if these specimens occurred chiefly at any particular period of the year, but the great number was remarkable, and rather puzzled him to account for on a supposition that they had been devoured.

Mr. Karop said that when *Vampyrella* went about it increased enormously, so that the quantity of the diatoms need create no difficulty in the supposition that this was a case of parasitism.

Mr. Goodwin thought it might be an early form of the diatom in which a gelatinous envelope was found. When he saw the specimens he noticed that they were seen in conjunction with the bundle of others in the same cyst lying at right angles to them, and so far as he remembered they were not fully grown.

The thanks of the meeting were voted to Mr. Robinson for his paper.

Mr. E. M. Nelson gave a lengthened *résumé* of the contents of his paper "On the Interference of Light," which he said was intended as a popular explanation of interference phenomena by presenting the ordinary Fraunhöfer formula in common language. He freely illustrated his remarks by diagrams upon the blackboard.

The President said he had listened to Mr. Nelson's paper with great interest, but he feared the subject was one which must necessarily be treated from a mathematical point of view, and that no one could grasp it without some previous mathematical training.

The thanks of the meeting were voted to Mr. Nelson for his paper.

The Secretary announced the date and particulars of the whole day excursion to Whitstable as arranged for by the Excursion Committee.

The proceedings closed with the usual conversazione, the following objects being exhibited :—

Plumatella repens	Mr. F. W. Andrew.
Puparium of Hessian fly (*Cecidomyia destructor*)	Mr. F. Enock.
Stained leaves	Mr. F. H. P. Hind.
Cyclosis in hair of *Tradescantia virginica* ...	Mr. G. E. Mainland.
Parasite from House fly	Mr. C. Rousselet.
Muscular fibre of Frog	Mr. T. F. Smith.

Attendance—Members, 45; Visitors, 2.

July 13th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Cristatella mucedo...	Mr. F. W. Andrew.
Serialaria lendigera	Mr. C. G. Dunning.
Parasite of Indian flying fox, *Nycteribia Hopei*, and drawing of same	Mr. F. Enock.
Section, Bud of water primrose, *Hottonia palustris*	Mr. H. E. Freeman.
Vaginicola crystallina	Mr G. E. Mainland.
Achorion Schonbeini	Mr. H. M. Simmonds.
Type slide of Diatoms from the Oamaru deposit	Mr. T. F. Smith.

Attendance—Members, 21 ; Visitors, 0.

July 27th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Cristatella, sp.	Mr. G. E. Mainland.
Photo-micrographs	Mr. E. M. Nelson.
Aspergillus glaucus in pig's lung	Mr. H. M. Simmonds.
Podura scales	Mr. T. F. Smith.

Attendance—Members, 18 ; Visitors, 3.

August 10th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Hydatina	Mr. F. W. Andrew.
Biddulphia echinata	Mr. H. Morland.
Pectinatella magnifica	Mr C. Rousselet.
Mycosis fungoides from a human tumour ...	Mr. H. M. Simmonds.
Craspedodiscus, sp.	Mr. T. F. Smith.

Attendance—Members, 18 ; Visitors, 2.

August 24th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Stalked eyes of *Phalangium*, sp.	Mr. E. T. Browne.
Actinomyces in abscess	Mr. H. M. Simmonds.
Pleurosigma angulatum	Mr. T. F. Smith.

Attendance—Members, 13 ; Visitors, 0.

September 14th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Plumatella repens	Mr. F. W. Andrew.
House fly, *Musca rudens*	Mr. E. T. Browne.
Eggs of Hessian fly, *Cecidomyia destructor*, in situ	Mr. F. Enock.
Triceratium castelliferum	Mr. H. Morland.
Indian fungus, *Chionypha Carteri*	Mr. H. M. Simmonds.

Attendance—Members, 28 ; Visitors, 2.

September 28th, 1888.—Ordinary Meeting.

B. T. Lowne, Esq., F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Thomas F. Hall was balloted for and duly elected a member of the Club.

The following additions to the Library and Cabinet were announced:—

"Journal of the Royal Microscopical Society" ...	From the Society.
"Proceedings of the Botanical Society of Edinburgh"	" "
"Science Gossip"	From the Editor.
"The American Monthly Microscopical Journal"	In exchange.
"Journal of the New York Microscopical Society"	"
"The American Naturalist"	"
"The Botanical Gazette"	"
"Proceedings of the Geologists' Association" ...	"
"Proceedings of the South London Entomological Society"	From the Society.
"Proceedings of the Hertfordshire Natural History Society"	" "
"Proceedings of the Croydon Microscopical Society"	" "
"Proceedings of the Belgian Microscopical Society"	" "
"Proceedings of the Northumberland and Newcastle Natural History Society"	" "
"Proceedings of the Royal Dublin Society" ...	" "
"Report of the Geological Survey of Canada"	From the Canadian Government.
"Journal of the Royal Society of New South Wales"	From the Society.
"The Quarterly Journal of Microscopical Science"	Purchased.
"Annals of Natural History"	"
"Proceedings of the Bristol Natural History Society"	From the Society.
"The Essex Naturalist"	From the Editor.
Series of 12 Slides of Oamaru Diatoms ...	From Mr. Morland.
" 8 " " " ...	From Dr. Gray.

The thanks of the meeting were voted to the donors, especially to those who had contributed the valuable collections of mounted diatoms.

A letter was read from the Hon. Secretary of the Ealing Microscopical Society, intimating that their Annual Soiree would be held on October 31st, and asking the assistance of the members of the Club on that occasion.

Mr. T. F. Smith read a paper on the "Structure of the Valves of *Pleurosigma*."

Mr. E. M. Nelson said he felt greatly obliged to Mr. Smith for his paper, which he considered to be of high value, and having seen the specimen described, he could quite confirm what had been said about it. He was the more glad to hear the observations of Mr. Smith, because he thought that to go hunting again and again over these specimens was the only kind of work of any real value. No doubt Mr. Smith had proved that there were several of those membranes, although it had not been possible to follow all that was contained in the paper the first time of hearing it. The difficulty had always been felt that in *Formosum* they never had been able to see the fracture passing through the holes; but now it had been shown that there was undoubtedly a perforated membrane; they could take it and see for themselves that it was a perfectly plain thing; indeed, if this was not real, then he could only say that all other things were "hocus pocus." With their very best lenses they had tried to find out about *Formosum*. Mr. Smith had found this fracture, had shown it to him, and demonstrated that the membrane existed, and that at any rate the fracture did run through the holes. There was still great trouble in determining the structure of *Angulatum*, which gave some most extraordinary appearances under some conditions. They hoped, however, to be able to understand it at some future time, especially now that Mr. Smith seemed to have cleared up some very difficult points in his paper, which he thought was one likely to be of great value.

Mr. A. D. Michael said the subject was a good deal out of his particular line, but he recollected a German paper being referred to some time ago in the "Journal of the Royal Microscopical Society," in which the author contended for a structure very much the same as that described by Mr. Smith, namely, an inner and an outer membrane or layer; the outer was said to be entirely without markings, and plane on its surface, and that the holes were entirely on the inner plane. This was said to be the reason why the cast of a diatom did not show any raised markings. Two membranes with a grating between and the markings on the inner membrane, was, so far as he recollected the paper, the idea of the structure.

The President said that the subject was quite out of his depth, for he had not paid much attention to diatoms, but he could only listen with admiration at the patience with which Mr. Smith had followed up his investigations. With regard, however, to the perforations which he had described, and which would appear to be about $\frac{1}{50000}$ inch in diameter, he thought they were talking about something which might or might not have an existence, but about which there was no certainty whatever. Of course it would not do to say they did not exist, but for his own part he did not believe that a ray of light could be passed through such a structure as that which had been described, and that afterwards it could be gathered up again so as to produce a reliable image of that structure. Taking, for example, the eyes of insects, the corneal lenses were, of course, quite outside the region of doubt, because being not much less than the $\frac{1}{1000}$ inch in

diameter they were capable of being made out with low powers. But if they took the great rods which were found under the cornea, and took a transverse section of them, it would be seen that each one presented the appearance of a number of bright points which were very minute, and were supposed to be the highly refractive fibres of the rods. A cross section of these was comparatively coarse beside what they had just been hearing about, and yet when these points were examined as they appeared in a section they could make anything they liked of them. They could be seen as six or as sixteen, and all the images produced were, he believed, equally faulty and defective, and he confessed that the more he looked at it the more he hesitated about it. This appeared to him to be a case in point, in which, putting the consideration of the retina on one side, the physical character of a ray of light was such that in attempting to determine the structure of the object they were simply theorizing. As he had already said, he did not profess to know very much about diatoms, but he flattered himself that he did know something of the laws of light, and he believed they might go on talking until doomsday without getting any nearer to a knowledge of what the actual structure was. But of course it would never do for them to say so—as microscopists.

Mr. E. M. Nelson read his papers "On Some Secondary Markings on Diatoms," and "Some Observations on the Human Spermatozoon."

The President said he had listened to Mr. Nelson's paper on the diatoms with great interest, and to the paper on Spermatozoa not only with interest, but also with astonishment. Mr. Nelson had found some very wonderful things in them; but if they went back to about the time of Charles II., when they were first examined, it would be found that there were some still more wonderful things discovered. They were said to have internal organs, and in fact to be perfect *Homunculi!* Of course, imagination went a long way in such cases, but he should like to ask Mr. Nelson whether those he had been examining had been properly fixed, because if not, all observations upon them would be absolutely worthless. A spermatozoon was simply a form of protoplasm—they did not even know that it had a membrane at all—and when it dries it cracks or becomes vacuolated, and presents any appearance possible other than what it had really been. If Mr. Nelson would examine organic structures of this kind properly fixed he would probably come to some other conclusions. Otherwise he was afraid that the knowledge obtained would not be of a kind likely to lead to any useful result. Certainly the amount of brilliant imagination displayed in what they had heard there that evening was very remarkable.

Mr. Reed said that Mr. Nelson had described some of the forms he had found as monstrous. One would, therefore, be glad to find what was a proper subject to furnish "standard" spermatozoa.

Announcements of meetings, etc., for the ensuing month were then made, and the proceedings terminated with the usual conversazione, the following objects being exhibited:—

Annelid, *Nais hamata*	Mr. F. W. Andrew.
Long. sec. *Cucurbita*, showing sieve tubes ...	Mr. W. J. Brown.

Desmids and diatoms from Penmaen Back ...	Mr. G. E. Mainland.
Ergot of Rye	Mr. H. M. Simmonds.
Pleurosigma formosum	Mr. T. F. Smith.
Asplanchna myrmeleo, ♂	Mr. G. Western.

Attendance—Members, 45; Visitors, 3.

OCTOBER 12TH, 1888.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Fredericella sultana	Mr. F. W. Andrew.
Diatoms from Samoa, with $\frac{2}{3}$ apochromatic O.G.	Mr. C. Lees Curties.
Vert. sec. flower bud of Sorrel, *Rumex acetosa*...	Mr. H. E. Freeman.
Hairs on leaf of *Durana*	Mr. W. Goodwin.
Volvox globator	Mr. G. Hind.
Rutilaria radiata	Mr. H. Morland.
Internal casts of Foraminifera from Macassar Straits	Mr. B. W. Priest.
Living Ascidian, *Perophora*	Mr. C. Rousselet.
Ferment, *Dispora Caucasia*	Mr. H. M. Simmonds.
Pleurosigma formosum	Mr. T. F. Smith.

Attendance—Members, 29; Visitors, 3.

OCTOBER 26TH, 1888.—ORDINARY MEETING.

PROF. B. T. LOWNE, F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Alfred J. Jenkins was ballotted for and duly elected a member of the Club.

The following additions to the Library and Cabinet were announced :—

"The American Monthly Microscopical Journal"	In exchange.
"The American Naturalist"	"
"The Botanical Gazette"	"
"Proceedings of the Natural History Society of Glasgow"	"
"Journal of the Royal Microscopical Society"	"
"Science Gossip"	From Publisher.
"Annals of Natural History"	Purchased.

The Secretary announced that the annual soiree of the Croydon Microscopical Society would be held on November 21st, at which members of the Club were invited to exhibit.

The President said that a very pleasant duty devolved upon him that evening, namely, that of presenting Mr. Alpheus Smith, on behalf of the Club, a testimonial of their appreciation of his very valuable services as their Librarian, services which had extended over a period of sixteen years.

The testimonial, consisting of a valuable gold watch and chain, an album containing an illuminated address, signed by all the contributors, and a

purse containing ten pounds, the balance of subscriptions received, was then handed to Mr. Smith as a small token of the indebtedness, as well as the esteem, felt by his fellow members towards one whose services had been so long and so cheerfully rendered.

The inscription from the album was then read as follows :—"This album together with a gold watch and chain and a purse of ten pounds is presented to Mr. Alpheus Smith by members of the Quekett Microscopical Club in recognition of the services rendered by him as Honorary Librarian for sixteen years. During this period his uniform courtesy and untiring application to the duties of his office have won for him their warmest gratitude and esteem."

Mr. T. C. White said he felt that this testimonial, handsome as it was, very poorly indicated their sense of the value of Mr. Smith's services to the Club. It was now about twenty-two years since he joined it as one of its first members, and during that period he had made many warm and affectionate friends, and was esteemed by all, not merely as a friend, but as a man who had stuck to his duty throughout. Night after night they saw the same faithful warder at his post, always ready to indicate to inquiring students the proper books to consult on subjects at which they were working. But there was one thing which he had done which had not been mentioned, and that was the making of an index to the six volumes which formed the first series of the Journal.* A collection of papers such as the Journal contained was, as they all knew, a very valuable one, but if they did not know what these were, or where to find them, their value was, of course, to a large extent lost, and in carrying out this as well as his other duties Mr. Smith had done, in his opinion, more than any other officer of the Club to add to its usefulness. He could not help making a reference to this, although he knew that all present would heartily endorse the words in which he had tried to express their thanks to Mr. Smith for what he had done.

Mr. J. G. Waller said he felt he must say something personally to express his own thanks to Mr. Smith for what he had done for them, because he had been so kind in every way, and had performed his duties in such an admirable spirit that he felt they owed a deep debt of gratitude to him which they could never repay, but which they sought to acknowledge in a practical manner that evening.

Mr. Alpheus Smith said he felt himself placed in a great difficulty, and must ask the indulgence of the members if he seemed to fail in giving adequate expression to his feelings, hoping that if words were wanting they would understand it to be due to his inability to thank them as he desired for their very great kindness on that occasion. He should treasure the testimonial, not only for its intrinsic value and its usefulness, but also as representing an expression of their goodwill, which he regarded still more highly. He felt very much obliged to the President and to Mr. White for the way in which they had spoken about him. Indeed, he did not know

* Mr. White referred to this as "the Catalogue of the Library." The correction is here made at Mr. Smith's request.

until then that he was half so good a fellow, and felt sure that they would hardly hold the same opinion if they knew his own heart as well as he did. He had to thank the members of the Club, not only for their gift, but also for the kindness which he had always received, and he would especially mention the three Secretaries under whom he had served, Mr. Ingpen, Mr. White, and Mr. Karop, as well as the other officers of the Club, from whom he had always received the greatest consideration. But beyond all that he felt he was indebted to the Club for much of the knowledge he now possessed upon microscopical matters. He was one of those who joined it early, for he saw the advertisement calling its first meeting, and it was only by accident—that of not possessing a microscope—that he did not attend that meeting. In the course of a month or two, when he had obtained a microscope, he wrote to Mr. Bywater, and was invited at once to attend. He soon afterwards joined Mr. Suffolk's classes on Manipulation and Mounting, and thus in one way or another got a great deal of practical information to add to the book knowledge which he had previously alone possessed. The service he had been able to perform had been a pleasure to him, and he should be very pleased to continue it as long as they felt that he could do so with advantage to them. He could only conclude his remarks as he began them, by thanking the members of the Club for their valuable present, and for the kindly expression of their feelings towards him.

Mr. J. E. Ingpen said he hoped he should not be considered out of order if he asked to be allowed personally to thank Mr. Smith for the valuable assistance he had rendered him during his term of office as Secretary. From the time of his election to that office in 1873 to that of his retirement in 1884 he had always found Mr. Smith at his post, and always ready and willing to help him in every way. He was anxious not to lose that opportunity of putting upon record his high appreciation of Mr. Smith's merit, and of heartily thanking him for his assistance, and for the many acts of kindness and courtesy received during the period to which he had referred.

Dr. M. C. Cooke said that it unfortunately happened that they were subject to a good many inconveniences as well as conveniences in London. Trains were apt to be late, and trains to go wrong, and so it happened that instead of being there in good time he had arrived nearly half-an-hour late. They might suppose that the reason for his appearance that evening was something rather important, and they would no doubt be able to surmise what it was. He had come down to say that he considered that the Club that night was doing itself great honour in thus doing what it had an undoubted right to do, namely, in recognizing the efficiency of the services of one of its officers—one whose constancy, punctuality, and urbanity were so well known to all. When he thought of all that had been done, and the way in which it was done, he could only look back with pleasure to this good example to them all. He was present, therefore, to express his strong approval of what they were doing that evening. They had a feeling in the Club that testimonials should not be given except under special circumstances, or when there were strong reasons for doing so—hence there was

the more honour attaching to them when they had been given. Whenever they had done so in the past he believed it had always been with good and sufficient cause, but on no occasion had there been more sufficient reason than upon the occasion then present. He was glad to have the opportunity of expressing how much he admired the work of their Librarian, as, indeed, he did that of any man who carried out the duties which he had assumed with a like degree of thoroughness.

Mr. H. Epps made a communication "On some forms of life found on the Cocoa Bean (Cacao Theobroma)." He had not prepared a paper, but had been giving the subject his attention for some years with a view to some day contributing one; meanwhile, he took the present opportunity of reporting progress, and asking the opinion of others respecting the development of the fungoid growth often accompanying the bean. As to animal life, he had found living in the beans the following insects, measuring from $\frac{1}{8}$ to $\frac{1}{4}$ inch:—*Aræocerus coffæa* (Trinidad and Bahia), *Carpophilus dimidiatus* (Trinidad and Maracaibo), *Silvanus advena* (Trinidad and Carupano), *Anthocoris nemoralis* (England), also two species of Tinea and one of Acarus. These insects, etc., were found in the cocoa-beans of commerce, he not having had any opportunity of seeing the cacao in the lands of its growth. Mr. Epps then dealt shortly with a few fungi found in cocoa-beans, and called attention to the causes that might regulate the varying development of the common blue mould, *Aspergillus glaucus*, and its dimorphic form, *Eurotium herbariorum*. Until comparatively lately the latter was thought to be a distinct fungus, and only with close observation could the two be traced, by the connecting threads of the mycelium, to be one and the same fungus, with two kinds of fruit. The dimorphic form—Eurotium—was a globose conceptacle, varying in size up to as large as $\frac{1}{32}$ inch; colours—white, yellow, red, or brown. He had been experimenting to trace, if possible, the conditions under which the size and colour of the Eurotium conceptacles varied. By saturating samples of sound beans with sea-water, salted water, rain-water, and distilled water, he had obtained varying results in the fungoid development, and was having his previous impression strengthened that the variations were not accidental, but that they depended on some direct causes or influences, although these may not yet have been identified, in opposition to the view usually expressed. He did not propose laying down any settled conclusion, as he intended devoting further attention and experiment to the subject, but he thought he might safely expect to find the *large bright* yellow Eurotium fruit in cocoa damaged by sea-water, and the dark brown fruit in cocoa damaged by rain-water, in addition to other varying forms of the mould, as large white, or *small faint* yellow conceptacles, and glaucous plumes. And it seemed to him a not unwarrantable impression to arrive at, that the colour of the fruit could be regulated by the presence of some one or other requisite stimulus, being developed by some natural chemical process, somewhat as a good gardener could regulate the size and colour of his roses. He could at any rate testify, as the result of a considerable commercial experience, that sea-damaged cocoa-beans were to be known by the presence of the large bright yellow

Eurotium fruit, while fresh-water or country-damaged cocoa-beans never in his experience had that form of the fungus present.

Dr. M. C. Cooke, in reply to the President, said he did not see how it was possible for him to make any observations upon the paper, because he had become painfully conscious either that he was getting old and deaf, or that the room was not the best in the world for hearing in. That he had been trying to hear might be taken for granted, because he imagined that subjects which he was supposed to know something about had been trenched upon, but beyond catching such familiar names as *Aspergillus glaucus* and *Eurotium* he had scarcely heard a word from beginning to end. He must, therefore, suppose that all that had been said was correct; but it might, for all that, be otherwise, and he must wait patiently until the proceedings were published in order to form any opinion, for if he was growing deaf he was not yet so blind that he could not see to read the Journal. He was sorry not to be able to make any other observations, as he should otherwise have been very glad to tread upon somebody's corns if the opportunity occurred.

The President said he knew very little about fungi, but he thought that, of the insects exhibited, only one species appeared to be a weevil, the others seeming more analogous to the death watch, or *Anobium*. No doubt the names given were correct, though he did not think they were all weevils.

Mr. S. J. McIntire read a paper "On a species of Coccus," which he exhibited under a microscope in the room. He had submitted it to Mr J. W. Douglas, whose letters concerning it were read to the meeting. He also referred to another species, which he exhibited, and which Mr. Douglas identified as *Lecanium acuminatum*.

Mr. R. T. Lewis regretted that he was unaware of Mr. McIntire's intention to bring this subject before them, as otherwise he could have brought to the meeting specimens of *Lecanium* and drawings of its various features, having recently received some from Mr. Douglas with a request for camera lucida drawings of the legs and antennæ. These specimens came from Ceylon, and appeared to be identical with those shown by Mr McIntire. Their minute structure was very interesting, especially as regarded the eyes and the branched marginal hairs. As there seemed to be some little interest attaching to the subject, he should be very pleased to present some mounted specimens to the Cabinet of the Club at the next meeting.

The President said they were much obliged to Mr. McIntire for bringing the matter before them. It was not one, however, upon which he felt qualified to make any observations, as he really knew very little about Cocci.

The thanks of the meeting were voted to Mr. Epps and Mr. McIntire for their communications.

Meetings, etc., for the ensuing month were then announced, and the proceedings terminated with the usual conversazione, the following objects being exhibited:—

Rotifer, sp.	Mr. F. W. Andrew.
Eggs of Hessian Fly (*Cecidomyia destructor*)	Mr. F. Enock.

Eurotium, form of *Aspergillus glaucus* ...	Mr. H. Epps.
Section of Leech, showing suckers	Mr. H. E. Freeman.
Palpal organs of Spider, *Linyphia montana*, ♂	Mr. G. E. Mainland.
Sarcina ventriculi	Mr. H. M. Simmonds.
Philodina tuberculata?	Mr. G. Western.

Attendance—Members, 67; Visitors, 5.

November 9th, 1888.—Conversational Meeting.

The following objects were exhibited :—

Sections, finger of monkey, and flower bud of Lily, with Zeiss' aplanatic × 10 ...	Mr. C. Lees Curties.
Indian tortoise beetle, *Platypria echidna* ...	Mr. F. Enock.
Leaf of Croton oil plant, showing bosses and hairs	Mr. W. Goodwin.
Diatoms from Oamaru deposit	Mr. G. E. Mainland.
Climacosphenia moniligera	Mr. H. Morland.
Nummulites, from Mokattam Hills, Cairo ...	Mr. S. H. Needham.
Human spermatozoa	Mr. E. M. Nelson.
Photo-micrographs	" "
Fungi in milk serum	Mr. H. M. Simmonds.

Attendance—Members, 37; Visitors, 2.

November 23rd, 1888.—Ordinary Meeting.

B. T. Lowne, Esq., F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were elected members of the Club :—Mr. J. H. Alabaster, Mr. E. E. Banham, Mr. H. R. Davies, Mr. W. C. Flood, Mr. Thos. G. Jefferys, Mr. G. W. Young.

The following additions to the Library and Cabinet were announced :—

"Proceedings of the Canadian Institute" ...	In exchange.
"The Botanical Gazette"...	"
"Proceedings of the Geologists' Association"...	"
"The Essex Naturalist"	"
"The American Naturalist"	"
"The American Monthly Microscopical Journal"	"
"Proceedings of the Royal Society"	"
"Science Gossip"	From the Editor.
"Report of the 'Challenger' Expedition" Vols. xxvii. and xxviii.	Purchased.
"17th Annual Report South London Natural History Society"	From the Society.
Two Slides—*Lecanium acuminatum*	From Mr. R. T. Lewis.

The thanks of the meeting were voted to the donors.

Mr. H. Morland read a paper entitled, "Notes on Mounting Diatoms."

Mr. Karop felt sure that this paper would be found most useful as a practical help to those who were interested in the subject. It often became his duty as secretary to badger members into giving them papers for the meetings, and he was glad to find that on this occasion he had badgered Mr. Morland to such good purpose. A short time ago he spent an evening with Dr. Gray, who was well known to many of the members as a very expert mounter, and in course of conversation on the subject it appeared that the bristle he had found most suitable was obtained from a cow's neck. He gave him some from a supply which he had. Dr. Gray said he never used the gum process at all, but he thought it might be useful when arranging the diatoms in series. He did not employ the breathing process either, and as a medium he simply used styrax, not diluted, but melted by the application of heat. It was well known that experts often arrived at the same results by different methods, and he thought it would be interesting to be able to compare Mr. Morland's procedure with that of Dr. Gray.

Mr. Morland said that the bristles he used were the finest he could pick out.

Mr. T. F. Smith said he had a type slide of *Aulacodiscus* in which nine-tenths of the diatoms were mounted with the spots the wrong side upwards. He should like to ask if it was not possible to put them on the slide the right way up?

Mr. Morland said most decidedly it was possible to mount them in any position, but he had no doubt they were mounted in that way because if placed the other way the gum would most likely run in and fill them up.

Mr. Michael said he had no doubt that the bristle which Mr. Morland used was very suitable for his purpose, but he should not like it to go out from there that the bristle from a badger's hair shaving brush was an invention of the books, because it was what he had been using himself for years; in fact it was his ordinary mounting instrument for delicate work, so that he kept a brush by him ready for use. A single badger hair put into a split lucifer match was the best instrument he knew of for his particular purpose, and though a stiffer one might do for diatoms, for more delicate purposes a soft bristle was most invaluable.

The President thought the members would agree that this was one of the most valuable contributions they had had upon this subject, and one for which they would no doubt accord a very hearty vote of thanks.

The thanks of the meeting were unanimously voted to Mr. Morland for his paper.

Mr. Rousselet read a paper on *Perophora Listeri*, illustrating the subject by diagrams and specimens exhibited alive under the microscope.

Professor Stewart said he had nothing to add to the paper which had been read, the subject of which was certainly one of the most beautiful creatures it was possible to find. He remembered seeing the creature many years ago, and thought it was the study of it which first led him to appreciate the value of the binocular microscope, which enabled him to see,

for the first time, the delicate pericardium. It was well shown in the room that evening, including the so-called sense organ or ganglia.

Mr. Michael said he had, at Mr. Rousselet's request, brought to the meeting the specimen of the larval Ascidian to which he had referred, but which was not the same species as that described in the paper. He would remind the members that this creature was the one on which Mr. Gosse made his famous observations as to the course of the blood. He fancied the species was freely distributed on the British coasts, and though first found at Brighton by Mr. Lister, it was common in other parts, particularly in Anglesea and in the North Sea. It was certainly a most beautiful and interesting species.

Mr. Waddington said it was not at all a rare object in many places. On all the clumps of Tubicolaria which they got at Whitstable on their las excursion there were specimens, and the one he exhibited that evening was upon a Tubicolaria stem obtained on that occasion.

The thanks of the meeting were voted to Mr. Rousselet for his paper.

Mr. Western said he had been reproached because he had made "Science Gossip" the medium of announcing something new. He therefore had brought to the meeting that evening another new species, *Diglena lacustra*, not hitherto found in Britain.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual conversazione, the following objects being exhibited :—

Limnias annulatus	Mr. F. W. Andrew.
Spinnerets of Spider, *Ciniflo similis*	Mr. G. E. Mainland.
Larvæ of Compound Ascidians	Mr. A. D. Michael.
Compound Ascidians, from Whitstable ...	Mr. F. A. Parsons.
Perophora Listeri	Mr. C. Rousselet.
Larva of an Ascidian	,, ,,
Cladothrix dichotoma	Mr. H. M. Simmonds.
Photographs, showing diatom structure ..	Mr. T. F. Smith.
Perophoira, growing on stem of tubularia ...	Mr. H. J. Waddington.
Diglena lacustris, Ehren.	Mr. G. Western.

Attendance—Members, 41 ; Visitors, 4.

Further Notes on Some Coccids from British Guiana.

By S. J. McIntire, F.R.M.S.

(*Read December 28th,* 1888.)

Plate XXVI.

With reference to a former communication in which I had the pleasure to read some letters from J. W. Douglas, Esq., F.E.S., upon certain coccids found by him on mango and orchid leaves from the Botanic Gardens, George Town, British Guiana, I followed up the subject by forwarding a piece of a mango-leaf and asking what the curious orthezia-like bodies upon it were. These curious clusters were the objects which had puzzled Mr. Jenman, the head of the Gardens, so much that he was glad when my friend Ward suggested that some leaves should be sent to me, and authorized him to take action accordingly.

Mr. Douglas replied as follows, sending me back the fragment of leaf on which he had found something which had escaped my notice:—

" The scales on the bit of mango-leaf (herein returned) are of the same kind as I found on one of the leaves received before—the male of a *Diaspis*, or *Chionaspis*—which I cannot determine without seeing the female scales (perhaps not then as to species). The *Diaspis* (female) has a more or less circular scale ; the *Chionaspis* an elongated or oval one."

" On the bit of leaf enclosed you will see a *very narrow black* coccid scale. This I have had on many plants from the Royal Botanic Society's Garden, Regent's Park, and described it in the 'Entomological Monthly Magazine' as *Ischnaspis filiformis*."

I have drawn both these coccids. The *Diaspis* or *Chionaspis* scales form white patches on the leaves, often of considerable size ; and in one or two places I have detected the imago, but I failed to remove it successfully to a slide, owing to its fragility.

The finding of *Ischnaspis* is interesting, as its native habitat was not previously known. So says Mr. Douglas, (" Entomological

Monthly Magazine," December, 1888). I intend to deposit the slide which settled that fact in the cabinet of the Club.

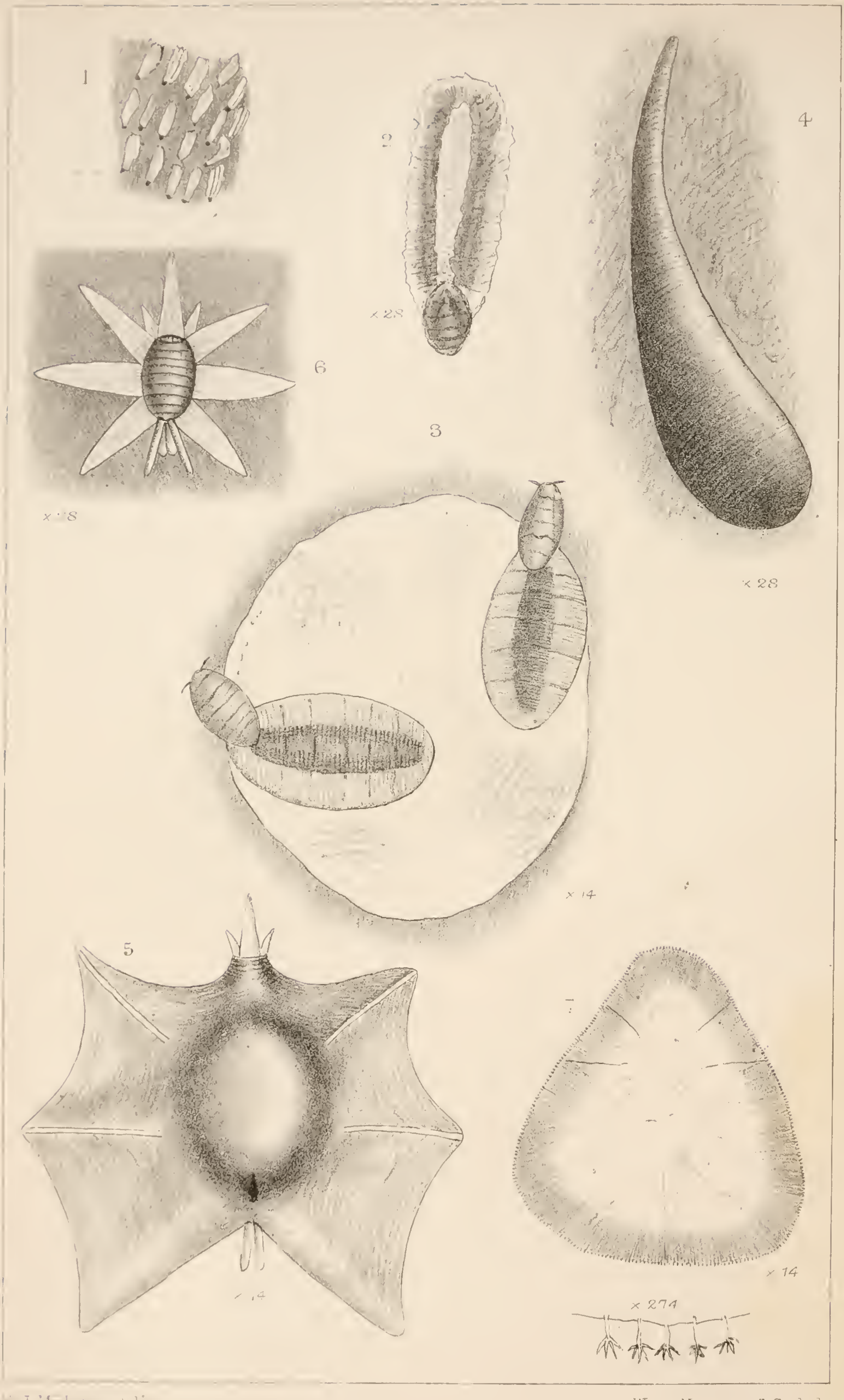
The specimens of *Vinsonia pulchella* (Signoret), but hereafter to be known as *Vinsonia stellifera* (Westwood and Douglas), that reached me this time are grand. Several were absolutely uninjured, thus enabling me to make a sketch of the immature and mature condition, between which I have got every stage. Perhaps I may quote the translation by Mr. Douglas of Signoret's description of the female insect.

" The pellicle which covers the insect is thin, of waxen appearance, corneous, transparent, forming on its disc a testudinate marquetry, and on each side radiating arms to the number of seven, of which one corresponds to the head, and the others to the stigmata ; there is also a very short one at the anus. We know only the female, which has the form of a star, the branches in all their extent covering the vacant space, which forms the stigmatiferous tube observable in all the *Lecanidæ*. At a more advanced age the secretion encroaches on the vacant space between the branches of the star, which then appear to be united by a membrane. The dorsal disc is convex, semi-globose. The secretion being removed, and then a corneous skin, the insect is seen beneath it, of a rounded, oval form, a little narrowed towards the head, blackish in colour, with a quantity of embryonic larvæ or eggs beneath it. The antennæ have six joints ; the first very broad, the third longest, equal to the last three together, the sixth longer than the two preceding it." (" Entomological Magazine," December, 1888).

In a conversation recently had with Mr. Watson, the Assistant Curator of Kew Gardens, he told me he believes he has seen this coccid on plants in the Gardens.

I will venture to say nothing about the coccid *Lecanium acuminatum*, which I have figured from a specimen on a mango-leaf, until Mr. Douglas has had his say on the subject first. This will be after my friend Ward has sent over some more leaves, especially orchid leaves, to clear up doubts in the mind of Mr. Douglas upon certain points.

He says :—" What I particularly hoped to get this time (but have not) was orchid-leaves with the small, flat, brownish scale, which I saw a few of on the orchids of the former lot, and which were also on the mango then sent, for I want to see if they are



S. J. McIntire del.   West, Newman & Co lith.

really the same. If you find any on the orchid-leaves you have now received I should be very glad to have them; if you have none, perhaps Mr. Ward would be good enough to send some."

In response to this I sent him the remainder of the leaves, but I fear there were none of the scales on the few orchid-leaves that came this time, such as he is in search of. There were, however, a few scales, different to any that had previously been noticed. So I drew his attention to these, and forwarded a rough sketch. His reply came after a few days, as follows:—

"Your sketch of the 14th instant represents the female of the small white scale, which is the male. I think at present, subject to further examination, that it is *Diaspis Cymbidii*. Ask Mr. Ward when he sends again to give the botanical name of the plants, that is, the orchids he sent leaves of. The sketch just received is probably the same species (female) as that of the 14th, but distorted by the action of a parasite. I am very glad to get these females. The skin at the end is that of its own larva. This is a character of the family *Diaspina*."

It only remains for me to express my indebtedness to Mr. Douglas for the valuable and interesting information he has so freely furnished, and to G. S. Jenman, Esq., F.L.S., of the Royal Gardens, George Town, for having started the subject.

I am quite sure Mr. Ward will do all in his power to assist us in further inquiries.

EXPLANATION OF PLATE XXVI.

Fig. 1. Scales of male *Diaspis*, or *Chionaspis*, on mango leaf.
„ 2. One of same, enlarged.
„ 3. Scales of female *Diaspis cymbidii*.
„ 4. „ „ *Ischnaspis filiformis*.
„ 5. *Vinsonia stellifera*.
„ 6. Immature scale of same.
„ 7. Scale of female *Lecanium** *acuminatum*.
„ 8. Margin of same, enlarged.

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* In my previous communication this name, which occurs three times, should have been spelt *Lecanium*.—S. J. McI.

Notes on the Larval Forms of Ortonia and Icerya.

By R. T. Lewis, F.R.M.S.

(*Read December 28th,* 1888.)

Plate XXVII.

It will probably be within the recollection of some of the members of the Club that in June last I brought to one of the meetings some living specimens of Coccidæ which had been forwarded by Mr. J. R. Ward, of Richmond, Natal, to my friend Mr. George Henderson, the Editor of the "British Bee Journal." Having taken them to the British Museum without being able to obtain any definite information about them, at the suggestion of our Vice-President, Mr. A. D. Michael, I placed myself in communication with Mr. J. W. Douglas, of Lewisham, to whom I forwarded specimens, together with such particulars as had come to hand. Having at his request subsequently furnished him with drawings of the legs and antennæ, he determined them to belong to the genus Ortonia, but regarding them as a hitherto undescribed species, gave to them the specific name of Natalensis, under which title they formed the subject of an interesting note by him in the "Entomologists' Monthly Magazine," Vol. xxv., p. 86, 1888. These creatures came through the post in a match box, and had apparently beguiled the tedium of the voyage by laying innumerable eggs of a delicate pink coral colour, minutely spotted with a darker tint. Some of these eggs I carefully secured in glass cells for future observation and experiment, the remainder I as carefully collected and destroyed as a precaution against the possible association of my name with the introduction of a new garden pest to this country. The adult specimens were placed in a glass covered tray, and were soon observed to produce a quantity of flocculent cottony material, which appearing first as a fringe round the posterior extremity, gradually increased until it extended like a train from one to two inches in length, amidst which eggs continued to be laid. This process went on for several months, during which I kept them under observation, until some

other matters of more pressing importance claiming attention, the tray was placed on one side for further reference if required. Towards the end of October last Mr. Ward again sent over a similar consignment of Coccidæ, with inquiries for information concerning them. On coming into my hands I found that in external appearance they differed widely from those which had been forwarded in May, each insect being, with the exception of its head and thorax, invested with a dense white felted material, presenting a longitudinally ribbed pattern upon its upper surface. On removing this—which proved to be the ovisac—the creature was seen to be somewhat similar in shape to *Ortonia Natalensis*, but differing from it both as to size and colour, being about one-third less in linear measurement, and red instead of pale chrome yellow. A cursory examination showed that the ovisacs of the insects, as well as the entire contents of the box, were strewed with detached legs and dried-up bodies of larval forms which had apparently been hatched out during transit, but which had been destroyed in a manner quite unaccountable until the discovery of a living ladybird amongst the *débris* clearly explained the mystery and led at once to its removal. One only of the adult specimens was found to be alive, but in the course of a few days more of the larvæ were hatched out, and I soon had a good supply of them for examination. Desiring further knowledge concerning them, I made drawings of the legs and antennæ of the full-grown insects and forwarded them to Mr. Douglas, together with some of the most perfect specimens I could find. He replied at once to the effect that both the legs and antennæ appeared to be practically the same as those of Ortonia, previously received, except as to size, which was not perhaps a matter of great importance. Being, however, very busy at the time, it seemed that he did not then open the box containing the insects, but on doing so a few days later he wrote to express his surprise at finding that the creatures were undoubtedly the notorious Icerya ; but the close identity between the antennæ and legs, before noted, led him somewhat to hesitate as to whether it might not become necessary to modify his opinion as to the species formerly designated Ortonia, the possibility having suggested itself that notwithstanding the differences in size, colour, and external appearance, the one might after all turn out to be a penultimate stage of the other. In this difficulty it occurred to me to refer again to the specimens of Ortonia which

had been put aside in August, a re-examination of which might, perhaps, throw some further light upon the matter. I found them all dead, each with its train of wool behind, but on turning them over I had the satisfaction of discovering upon the under side not only that some of the eggs had recently hatched, but also that a number of living larvæ were still clinging to the body of the mother. On placing them under the microscope it was at once apparent that my hope had been well-founded, and that sufficient differences existed between the larvæ of the two forms to impress even a casual observer with the fact that he had before him two distinct species. Having made drawings upon the same scale of the larvæ of each form, I forwarded them to Mr. Douglas, and was glad to hear from him in reply that he regarded the evidence thus afforded as quite conclusive in establishing the fact that the two kinds were entirely distinct from each other.

In illustration of these notes I have placed under a microscope in the room some living larvæ of Icerya, whilst under another is shown a mounted specimen of the larva of Ortonia; I also submit a drawing of each, made accurately to the same scale, in order to facilitate comparison. On examining these (see Plate XXVII, Figs. 1 and 2) it will be seen that the two kinds are alike in having bodies of a bright coral red, and that, so far as the number and proportion of joints of antennæ and legs are concerned, there is also a tolerably close resemblance. There is, however, a considerable difference in the size of the creatures, for although of the same age within a day or two, the larva of Ortonia measures ·9 × ·45 mm., as against ·6 × ·3 mm. in the case of that of Icerya, a proportion, it may be noted, about the same as that between the average adult specimens of the respective genera. The same relative proportion exists as to the lengths of the antennæ, but whereas the two longest terminal hairs carried by Ortonia do not exceed ·175 mm., those of the smaller insect measure not less than ·825 mm.; the hairs on the sides of the body, on the other hand, are longest in Ortonia, reaching ·5 mm., as against ·1 mm. in Icerya. A still more striking difference is apparent in the long and delicate hairs extending from the posterior extremity. These in Ortonia are four in number, and ·85 mm. long, whilst in the smaller Icerya there are six, with an average length of no less than 1·2 mm., or about twice the length of the creature itself. Each claw in both species is furnished with a pair of the recurved knobbed hairs (absent in the adult) common

R. T. Lewis del^t. West, Newman & Co. lith.

amongst the Coccidæ, but in this case too delicate to be shown upon the scale of the figures drawn, requiring a good $\frac{1}{2}$ inch objective to demonstrate them satisfactorily (see Fig. 3).

Icerya being well known as a troublesome pest in the Southern States of North America, as well as in South Africa and elsewhere, it seemed desirable to ascertain the name of the Coccinella which had proved itself to be such an effective destroyer of the larvæ. It differed from our native species chiefly in the colour of its legs and the under surface of the body, which were a bright crimson instead of black, and on submitting it for identification to Mr. C. O. Waterhouse, of the British Museum, he kindly informed me that it was a *Rodolia*, but what species he was unable to say.

The difficulties usually attendant upon efforts to obtain good mounts of such delicate and fragile creatures, which the weight of a thin cover glass alone frequently sufficed to crush, were enhanced by the fact of the deep yellow stain which they imparted to most of the media employed; the resemblance between the colour of the insects to that of a crystal of bi-chromate of potash, and of the resulting stains from an infusion of ether, could hardly fail to be remarked. After numerous experiments the best success seemed to attend attempts to preserve them in a thick solution of Canada balsam in benzole, a drop being allowed to fall upon the larva as it walked upon the slide, and the cover glass laid thereon at once without pressure.

EXPLANATION OF PLATE XXVII.

Fig. 1. Larva of *Ortonia Natalensis* × 45.
„ 2. „ *Icerya Purchasi* × 45.
„ 3. Tarsus and Claw of Larva of *Ortonia* × 162.

On Interference Phenomena in Relation to True and False Images in Microscopy.

By B. Thompson Lowne, F.R.C.S., F.L.S., &c.

(*Read January 25th*, 1889.)

Whilst we all admit that Professor Abbe has done excellent work in elucidating a theory of microscopic vision, many of us regret that he has apparently thrown a bone of contention in the way of some of the most earnest seekers after truth.

When our old friend and Vice-President, Mr. E. M. Nelson, read his paper at the last meeting of the Society, I thought it was high time that I should more fully study Professor Abbe's views, and that I should settle, in my own mind at least, the question as to whether my opinion or Mr. Nelson's was correct upon the subject of diffraction phenomena.

I am ready to confess that for some years past I have supposed the question of diatom structure to be so inseparably connected with diffraction phenomena that I entirely disbelieved it could be definitely settled. I, however, set myself to work to consider the effect of diffraction on the image, and I worked out, by the usual formulæ, the appearances which should occur in certain cases if the images were false. Theoretically it appeared to me that the various figures given of diatom structures depended on the aperture of the objective; and that the progress of microscopical improvement in this respect, with the increase of delineating power, supposed by Professor Abbe to be due to diffraction, agreed in the main with the altered diatom appearances recorded by successive observers.

I then took counsel with your Vice-President, and asked him to show me some of his diatoms. You all know Mr. Nelson's skill in this department, and I came from his house fully convinced that he had shown me true images of actual structures.

I felt strongly that the usual views with regard to Professor Abbe's researches, in this country at least, needed revision, and I half felt that the professor's chief supporters were dogmatizing on

a subject of extreme difficulty, which they did not entirely comprehend.

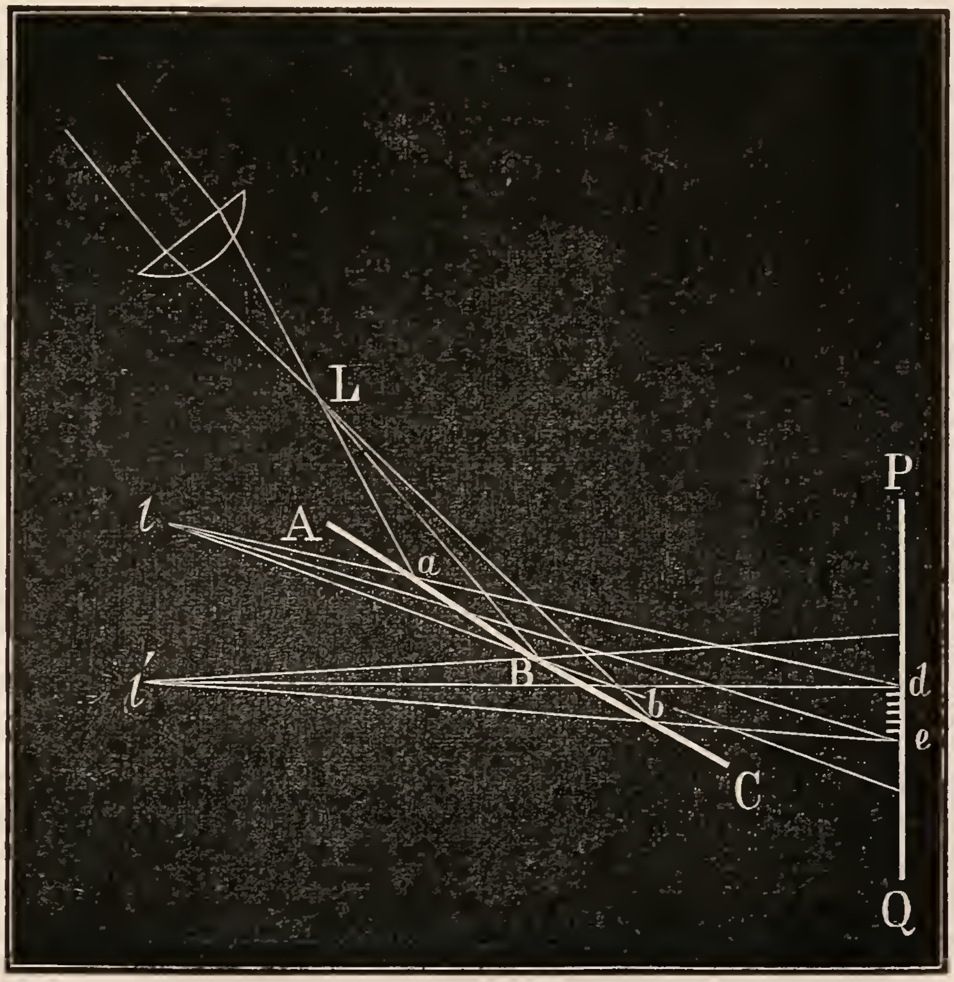
I have read Professor Abbe's papers with great care, and although I cannot quite fix the statement which has so frequently been made—that the investigators of diatom structure and all very minute objects are wasting their time—at Professor Abbe's door, I feel this is the legitimate conclusion to be drawn from the statements he makes.

I. On Interference.

Interference phenomena depend on the joint action of two light waves. Of course, all the light waves which fall upon any surface act jointly, but for the action to produce a visible result it must continue for an appreciable time. The interferences which occur from the joint action of two luminous bodies on any surface cannot be perceived, because each sends vast numbers of waves in every possible phase to the surface, in every second.

If, however, we allow the light from a luminous point, say the focus of a condenser, to fall upon two metallic mirrors, A B C (Fig. 9), placed at an obtuse angle to each other, the pencil of light L *a* B which falls on A B, is reflected upon the screen P Q, as if

Fig. 9.



it came from l ; that which falls on B C, L B b, is reflected as if it came from l'. So the screen between d and e is illuminated by light, as if from two sources, l and l'. As every wave is split into two parts, whatever its phase, we may consider l and l' as two exactly similar sources of light, one the exact image of the other; each with exactly the same luminous particles in similar positions with regard to each other, one emitting light always in the same phase as that emitted by the corresponding particle in the other, at every instant.

It is obvious that no two natural sources of light could do this, and that no two particles emitting light could have such a relation to each other.

The portion of the screen P Q between d and e which is illuminated by rays which may be considered, as I have shown, to be proceeding from the points l and l' (which are in every respect identical), will exhibit alternate bright and dark bands, parallel with the line of junction of the metallic mirrors A B, B C. The screen will exhibit a black band wherever the distance from l to the screen is $\frac{1}{2}$, $\frac{3}{2}$, $\frac{5}{2}$ of the length of a light wave longer or shorter than the distance from $l\prime$, and a bright band, wherever the two paths are equal or differ by the length of 1, 2, 3, 4, etc., light waves. In the former case the crest of a wave from l falls into the hollow of the wave from l', and their joint effect is that no disturbance or wave is propagated from the point, in the latter a crest corresponds with a crest and the action of the two waves is added, so that the light proceeding from the point is the same as that produced by the two waves.

II. On Diffraction.

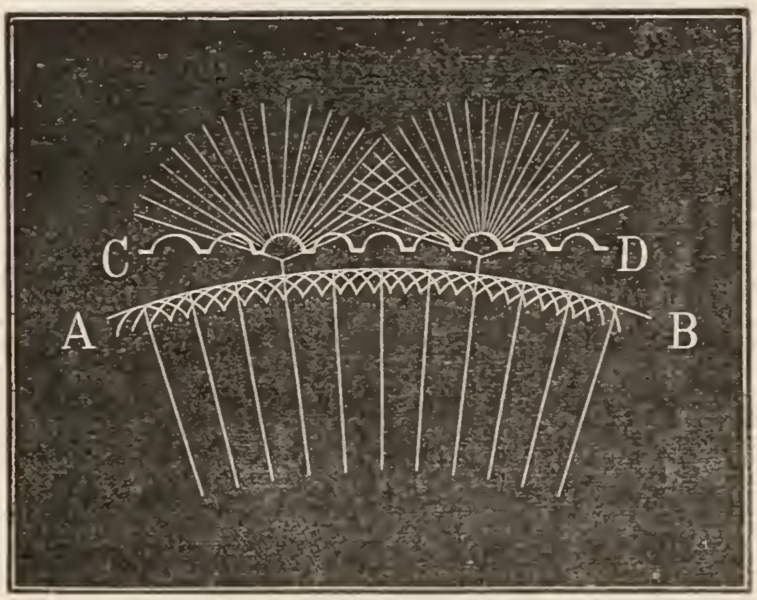
There is a well-known difference between light and sound ; if we admit a beam of light into a dark room through a hole in a shutter, the beam only illuminates the wall exactly opposite the opening, whilst in the case of sound the disturbance is equally propagated in all directions after passing through the aperture. The reason is that the opening is very large in proportion to the magnitude of light vibrations and very small in proportion to sound vibrations. If the size of the aperture be reduced in the case of light so as to be small in proportion to the size of light waves, then light, like sound, is diffused after passing through the opening. Such diffused rays of light are said to be diffracted at the opening.

Not only is light diffracted in passing through an opening, but

it is diffracted by opaque bodies when sufficiently small, so that a minute globule of mercury produces a diffraction image consisting of concentric rings of light and darkness when seen with the microscope by illumination from below. These rings result from diffraction and interference conjointly.

The cause of diffraction may be explained as follows.

FIG. 10.



Suppose the light, Fig. 10, to proceed from a luminous point, it will have a great wave front, A B, made up of thousands of small wavelets. As these are close together, the lateral disturbances annul each other. But now suppose a narrow grating, C D, interposed with spaces just wide enough each to allow a single wavelet to pass through, the light will radiate from every point in each clear space ; that is, the light will radiate equally in all directions beyond each opening. As every wave which comes up to the obstacle is split into as many little waves as there are openings, this light will exhibit interference phenomena if it fall on a screen, and the screen will exhibit alternate lines of light and darkness.

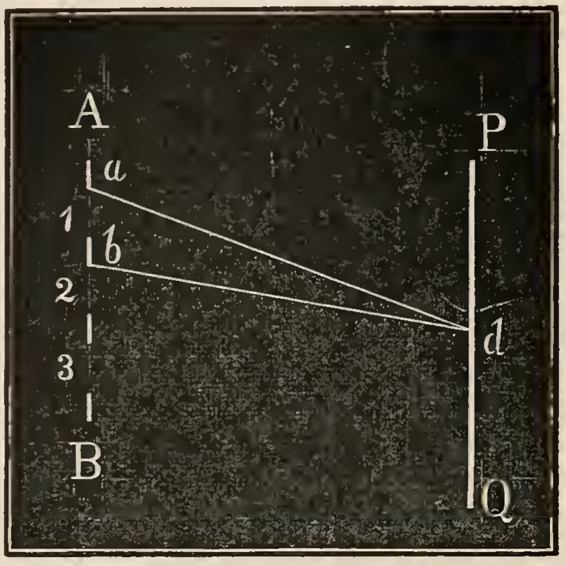
Let 1, 2, and 3, Fig. 11, be three successive openings ; let *a d*, *b d*, be two rays falling together on the screen ; the point *d* will be light if the waves strengthen each other, as when the path $a\ d = b\ d$.

They will annul each other when the path *a d* is half a wave longer or shorter than *b d*, and the screen will be dark.

All minute objects, when illuminated from below, even those measuring $\frac{1}{1000}$ or more of an inch in diameter, produce diffraction and give rise to interference, which results in more or less modified images. Diatoms are more especially liable to produce marked

interference images. Such test objects as Noberts' plates and fine lines ruled on silvered glass are especially adapted for the investigation of the nature of such images, which are usually, though not perhaps invariably, false images.

FIG. 11.



If we examine Noberts' test-plate with the microscope by a narrow pencil of transmitted light the lines will produce bands of alternate light and darkness, crossing the objective, but there will be no real loss of light, because the bright bands are twice as bright as they would be if the light fell all over the objective, and the dark bands are the same breadth as the bright bands.

As the surface of the objective is indifferent, one part, theoretically at least, having the same value as another, the kind of interference I have described has no effect on the ordinary image.

III. The Formation of Images and Diffraction Spectra.

I must now ask you to remember the manner in which a microscope acts. When you see an object clearly, it is in focus; if you remove the eye-piece, the relation of the object to the objective is this:—The object lies in the anterior conjugate focus (Fig. 12, *o*), which corresponds to a posterior conjugate focus, in the plane of the eye-glass (*e*); that is, the magnified image of the object lies exactly at the same level as the eye-glass occupies when in position.

Now, the diaphragm of the condenser, *n*, by which your object is illuminated, is further from the object-glass than the object, therefore its conjugate focus is nearer to the object-glass than the eye-piece, for example, at *h*; in general its image is just above the object-glass. When a grating like Noberts' test-plate is between the object-glass and the source of light, if you look down the tube, the eye-piece having been removed, you see a central

FIG. 12.

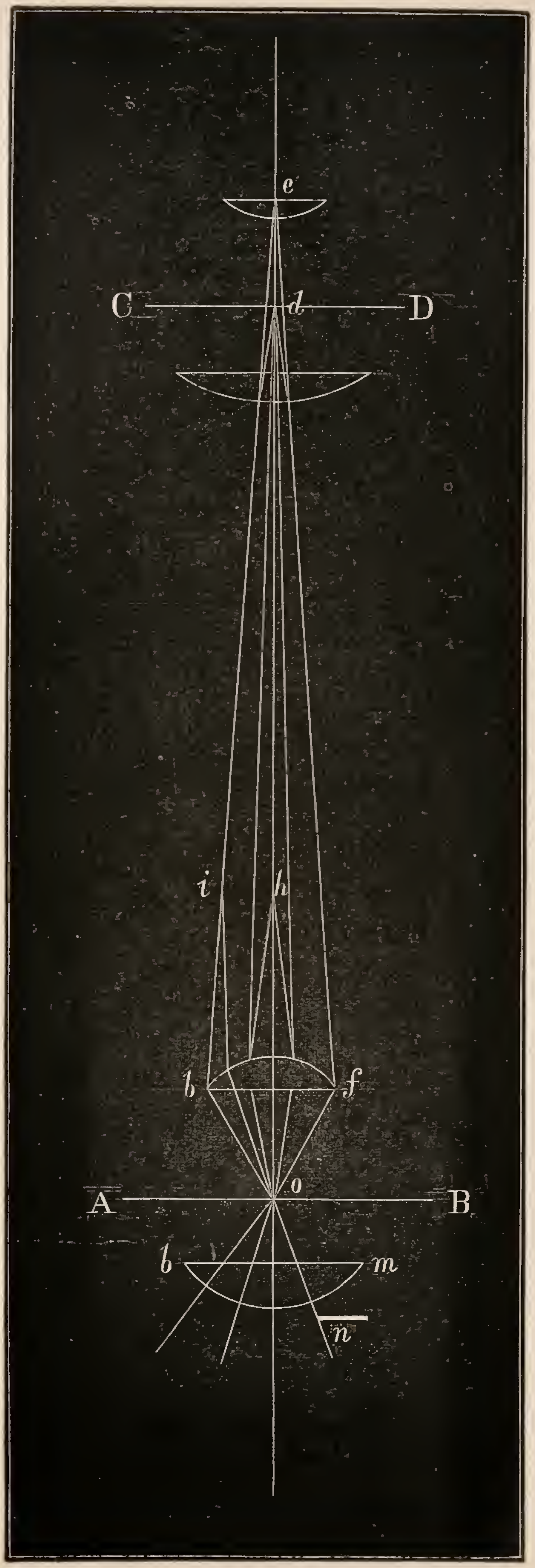


image of the bright opening, near the object-glass, and on either side of this another image of the diaphragm corresponding to each bright stripe on the object-glass ; that is, where the diffracted beams do not interfere with each other. These images are necessarily positive or bright, and lie nearly in the plane *i h*. As the light is not homogeneous, and the violet rays are less diffracted than the red rays, there is a spectrum instead of an image, corresponding to the diffracted bright rays, with the red outside and the violet inside. These are called diffraction spectra. The spectrum consists of coloured images of the source of light. When the lines on the plate are very close together the spectra are correspondingly lengthened, and as the dark spaces equal the bright ones, the narrower the spaces in the object the further apart the spectra are, and the greater the aperture required to receive them. If the grating consists of crossed lines the spectra form crosses ; if of hexagonal fields or minute circular openings corresponding to the centres of such hexagons there are six spectra in a circle, and so on.

Now, it will be seen that the rays of light which produce these images can have nothing whatever to do with the picture or image (*d*) produced when the eye-piece is in its place. The light proceeding from the diffraction spectra, towards the eye-piece, is divergent light proceeding from the images of the diaphragm in the plane *i h*. The light which gives us the image, which we see with the eye-piece, is light converging from the object-glass to the plane of the eye-glass. The field glass brings this convergent light to a focus (*d*) between the field-glass and the eye-glass, in the plane of the focus of the eye-glass. Try with an eye-piece to see an object eight or ten inches in front of the field-glass, you cannot. You can see nothing through an eye-piece used as a telescope or magnifying glass, because it is adapted only for converging rays, and no natural object gives out converging rays. The focus of the eye-piece of a microscope is virtual ; that is, it is nearer to the eye than the diaphragm between the field-glass and the eye-glass. It is, as I have already stated, in the plane of the eye-glass.

Now, it is generally believed, since the publication of Abbe's papers, that the appearance of the image seen depends on the diffraction spectra. There could not be a more profound error.

Professor Abbe says that if you block out these spectra you lose the details in the image. This is true where the detail is due to interference, as the image-forming light passes through the same

parts of the objective as those rays which give the spectra, and you cannot, therefore, block out the spectra without also destroying the diffraction image.

Let us now see what diffraction and interference have to do with the formation of an image.

Professor Abbe says the image consists of a dioptric image with numerous partial *positive* diffraction images superimposed upon it. The image is a true image of structure wherever all the partial diffraction images which can be formed by the object are exactly superimposed upon each other, without any displacement due to spherical or chromatic aberration. He further says the image cannot be depended on unless ALL the rays which have any SENSIBLE illuminating power are collected by the objective.

First, the dioptric image depends upon the well-known optical law—that a perfect system of aplanatic achromatic lenses brings all the rays which come from a point in the object to a corresponding point in the image. The more nearly these points in the image become mathematical points the sharper the picture.

With ordinary illumination, Professor Abbe assumes that the centre only of a wide angle object-glass is concerned in forming the dioptric picture. His "*ordinary illumination*" means a very small pencil of light from the condenser.

The pencils of diffracted light which come from points in the object are also subject to exactly the same dioptric law. They are also brought to exact focal points, corresponding point for point with the corresponding points in the object.

In physical optics, a focus is defined as a point at which the vibrations arrive at the same time, and in the same phase. There can, therefore, be no interference within the limits of the diffraction pencil.

Now, suppose we take the case in which we have a diffracted pencil and a dioptric pencil; the simplest case, according to Professor Abbe, in which we can have delineation ("abbildung") of details in the image. What happens to produce these details?

The dioptric beam gives the illumination of the field by superimposed diffusion circles, its foci being those of the source of light. These interfere with the foci of the diffracted pencil, and whenever the light waves are in different phases a negative or dark image is formed. This is the diffraction image. If the focal points of the diffraction pencils correspond point for point with those of the object, the black image in that plane represents the object exactly,

but at higher and lower focal image planes false images are produced. As the black lines forming the image depend entirely on the different paths of the two beams, they are independent of the structure producing them, and give, as Professor Abbe justly observes, no indication of real structure.

It may not be quite clear how the dioptric and diffraction pencils interfere. This depends on the fact that the diffraction pencil consists at its origin in the object of exactly the same waves, and of waves in exactly the same phase as the direct or dioptric pencil, from which it is split off by diffraction. All the conditions of interference are present. In all this I agree, I believe, entirely with Professor Abbe, and if this included all the phenomena, Professor Abbe and his supporters would be entirely right in saying that the search after true images is futile whenever the objects are very small.

Every practised microscopist knows the false diffraction images well enough; they present a peculiarity which at once differentiates them from true images, such as can be called critical. They alter in a continuous manner with every small alteration of the focus. By altering in a continuous manner, I mean that dark circles, rosettes, eye spots, etcetera, enlarge and contract; points open out into rosettes or rings, rings or rosettes close up into points.

Anyone may convince himself of this if he places a diatom on the stage, and illuminates it from the condenser with a very narrow pencil of central light, even with a coarse object like *Triceratium favus*. A narrow pencil, obtained by closing the iris diaphragm of the condenser, gives the diffraction images with great perfection.

What, however, does the critical observer do? He opens his diaphragm so as to give an illuminating pencil equal in angular divergence to the aperture of his objective. Do this, and all the diffraction images vanish.

Professor Abbé says:—"In general such a pencil entirely destroys the delineating power of the microscope for very minute objects and high angles of aperture."

In proof of this the experiment with Noberts' plate is given as an example. If you open the condenser diaphragm the lines disappear. This shows that there is no image of those lines, except a diffraction image. Such fine scratchings on the glass are really invisible, but they give diffraction lines which are visible. The structure of Pleurosigma is visible under conditions which render the diffraction lines produced by the ruled test-plate invisible; therefore they are not to be classed in the same category. Every

critical observer knows lines crossing each other diagonally on the valve are false, not true images. They are, however, Professor Abbe's "Delineation of structure."

A diffraction image is not necessarily a false image, but it is impossible to tell which of the numerous diffraction images is the true one; therefore the critical observer uses conditions which destroy the diffraction image.

That the wide illuminating pencil which covers the aperture of the objective destroys the diffraction image is easily proved; and theoretically it should do so. The greater the amount of light—that is, the larger the cone of direct rays, as distinguished from those which are diffracted—the less the effect of the diffracted rays.

If we remove the eye-piece from the microscope we observe, under such illumination, that the dioptric or central pencil occupies the whole back of the objective, and that no diffraction spectra can be seen. There is no doubt they exist, but they are too feeble to produce any visible image. This is the condition of illumination insisted on by all who have worked at critical images of diatoms.

Critical images such as Mr. Nelson and Mr. Smith will show you, exhibit none of the phenomena which are always present with diffraction images.

The diffraction images alter with an altered focus; the critical image disappears; it has one sharp focus and one only. The dark or bright lines seen, which are really diffraction images, with a Noberts' plate or lines on silvered glass, have no individuality; for example, a diamond scratch on glass has splintered edges, it is an irregular furrow. The diffraction images are sharp lines, quite unlike the real lines existing on the glass. In the critical image of the diatom on the other hand, each opening has an individuality of its own. Spicules project from its margin, it is smaller or larger than the average; lines of fracture are distinct; all appearances well known and insisted upon by the critical worker. Lastly, the diffraction image disappears with a full pencil of light with the diffraction spectra, whilst the critical diatom image can only be obtained by such illumination. Everyone now admits that the illuminating pencil must be direct and not oblique, whilst, as Abbe has distinctly shown, the oblique pencil gives the best results so far as diffraction images are concerned.

To test this question I broke up a globule of mercury, with an elastic stick, upon a glass slide, and mounted the preparation in

balsam. The slide contains thousands of globules of every degree of fineness, many not more than half a micro in diameter, $\frac{1}{50000}''$. Yet when illuminated with a wide pencil, covering the aperture of the lens, all diffraction rings disappear with an oil-immersion lens at the correct focus, and each globule, however small, is visible as a small dark disc. It is easy, of course, to see the globules, like cells with round nuclei, especially with objectives of small angle, to get two rings round such a globule, or to make them appear like transparent objects by altering the focus. Yet any critical worker knows at once he has diffraction images to deal with, and he alters his focus and illumination until he gets the definite unalterable image.

With a glass having a small aperture it is impossible to get rid of the diffraction images in all cases, but when the aperture is large I believe this can always be done.

As in most cases of controversy amongst scientific men, with which I am acquainted, the disputants are talking about different things. What Professor Abbe regards as "delineating power" and "detail" is detail which no critical observer of diatoms would recognize as delineation. Professor Abbe, working under different conditions, regards a diffraction image as detail. No one supposes that the lines of Noberts' plate are themselves visible.

That diffraction may and does show us objects that we could not possibly see without it is undoubted, and such objects must be interpreted as best we may, but that the diatom structure is one of these cases is certainly not true, and when you have a critical image such as Mr. Smith or Mr. Nelson can show you, you will find no diffraction spectra are visible, as the whole aperture is flooded with light.

The questions naturally arise, if this be true what have we in the place of a diffraction image? and what advantages arise from the use of lenses with a large numerical aperture and of immersion lenses respectively?

I shall now endeavour to answer these questions.

IV. Positive and Negative Images.

The images seen with the microscope are either brighter or darker than the illuminated field. An opaque object appears black; when illuminated from below it gives a negative image. A transparent object seen by transmitted light is less bright than the field, *i.e.*, gives a negative image, whenever it absorbs much light,

and whenever it has a lower refractive index than the medium in which it is mounted, except when it acts as a concave lens; it is brighter than the field whenever it has a higher refractive index than the medium in which it is mounted, except when it acts as a concave lens, *i.e.*, it gives a positive image.

Diatoms have a lower refractive index than balsam, and seen by transmitted light should give, in the majority of cases at least, a negative image. Such a negative image is always complicated with diffraction images, and is only seen with object glasses having a low numerical aperture. The dioptric image is necessarily feeble, as the diatom permits much light to pass through it, and delineation is only possible by means of diffraction images.

The case is, however, very different with high angles of aperture, and especially with immersion lenses; the diatom image is then positive; it is brighter than the field. How can this arise? The diatom is self-luminous, *i.e.*, in the same sense that a piece of white paper is self-luminous. Every point of the diatom radiates light, and every point is an independent source of light, that is, the light radiates independently from every point, the vibrations proceeding in every possible phase at every instant, such light producing no visible interference phenomena.

The cause of the positive image is that the diatom is illuminated from above, not from below. It is illuminated by reflected light from the upper surface of the front lens of the objective.

It is well known that the pencil of light which falls upon a plate of glass is partially reflected chiefly from the surface of emergence. This surface of emergence of the front lens is a concave mirror, which condenses the reflected pencil upon the object. A very simple experiment will convince the most sceptical of the great illuminating power of the back of the front lens of an objective. Take a black-handled pocket-knife, the smaller the better, with a bright stud upon it, hold it up between the eye and a gas-burner, near the source of light; the stud is invisible. Take an ordinary pocket lens of an inch focal length or thereabout, and without moving the knife focus it upon the stud; it will be brilliantly illuminated.

Any convex lens will give a brilliant inverted image of a flame upon a small screen placed between it and the source of light, by reflection from its back surface. Moreover, if we look at the lens the virtual erect image of the flame seen on its back surface is nearly as bright as the source of light, although, of course, much smaller.

With objectives of large numerical aperture the working distance is short, and with a large pencil much light is reflected upon the object. With immersion lenses the reflection from the cover glass and the front of the objective is practically done away with, so that all the light reflected from the upper face of the front lens falls upon the object.

Five per cent. of the light which falls normally on the back surface of a glass lens is reflected, whilst the quantity which is reflected by oblique incidence rapidly increases; much light is totally reflected, the whole converges after reflection once, twice, or thrice towards the object, and it must be remembered that only the centre of the pencil falling upon the back surface of the front lens is transmitted to the eye, whilst the whole pencil is concerned in the illumination of the object from above.

I believe that this is the great advantage derived from high angles of aperture, and more especially from immersion objectives. The elimination of the false diffraction images resulting from the large illuminating pencil and the reflection of light from the object appear to me to be the causes of the great increase of definition attained by their use. The view propounded by Professor Abbe that they collect outlying diffraction pencils appears to me quite inadequate to explain the increase of definition.

[Since I read the above paper I have made numerous experiments with my oil-immersion lens, to determine as far as possible the illuminating power of the reflection from the back of the front lens.

I have mounted a number of objects which are known to be quite opaque, such as oxides of metals in fine powder or granules, crystals of silver, etc. These objects are seen to be quite black, or nearly black, with air lenses of low angle, but are brightly illuminated from above with an oil lens. Thus tin oxide has the appearance of white spar illuminated by the direct rays of the sun. The black crystals of silver are frequently intermixed with white crystals with a metallic lustre, these are seen on the surface of large black masses most brilliantly. The globules of mercury already alluded tō give a bright central image of the flame of the lamp, and appear as metallic globes when the illumination is properly adjusted. I am still engaged in these experiments, and will bring the matter before the Club as soon as my experiments are concluded.]

On the Anatomy of Insects.

Address of the President, B. Thompson Lowne, F.R.C.S., F.L.S.

Delivered at the Annual General Meeting, February 22nd, 1889.

As the Quekett Microscopical Club consists of workers in all the various branches of microscopical science, and my own line, the anatomy and development of insects, is a very special one, I felt that on the present occasion it would be well if I could address you on some subject which would have a more general interest than the detailed account of some one or more of my recent researches could possess for many of you.

As I do not feel myself competent to deviate too far from my own special work, it occurred to me that I could best fulfil my object by giving you a historical *résumé* of the progress which has been made in my own department since Swammerdam inaugurated the work more than two hundred years ago.

The Dutch anatomist may well be called the father of the subject, as little or nothing was known before he undertook the investigation.

Jan Swammerdam was born in Amsterdam, in 1637. His father was a well-known naturalist at the time, and had what was then a wonderful museum. Jan was first intended for the Church, but as from his earliest years he exhibited a great love for natural history, he eventually went to the University of Leyden to study medical science; and there he made friends of Stenson and Graaf, and devoted himself to anatomy. He had written and published his great work on the "Anatomy of Insects" before he received his degree of Doctor of Medicine; it appeared at Utrecht in 1669. This work became, as it deserved to be, the standard work on the subject, and stood alone for over one hundred years. It was published in German, Dutch, and Latin, and went through several editions. The best is perhaps the Leipzig edition of 1752.

Swammerdam continued to work until he was about fifty-five

years of age, but he became a religious enthusiast some years before his ultimate breakdown, and, like his fellow-worker Stenson, was, I fear, insane for some years before his death, which took place in 1680.

Boerhaave fortunately became possessed of all his best manuscripts, and incorporated them with his earlier work, and the whole were published under the title of "Bybel der Natuure," in the Leyden edition of 1737 in parallel columns of Latin and Dutch.

There is only one fact which forbids me to recommend this work to you for perusal: it is that eighteenth century Latin is not generally considered entertaining reading.

With regard to the book itself, I regard it as a most wonderful record of patient research, tinged, of course, with the pious teleology which was in vogue at that period; and vastly important from a historic point of view. In some of the later researches there is, however, I think, evidence of the impending disaster which appears to have shattered his great intellect.

If any be inclined to regard the classification of insects, in which class snails and bivalve molluscs are included, proposed by Swammerdam as little better than chaos, it must be conceded that he founded that classification upon true principles—the developmental history of the individual. It must be remembered that Linnæus was not born, his "Systema Naturæ" appeared in 1735, more than half a century after the death of Swammerdam. The "Systema" was followed by the works of Fabricius, 1775, and De Geer, 1776, who elaborated the classification of the great Swede, but it was not until the beginning of the nineteenth century that a fairly complete classification of insects was attempted—the work of Savigny and Latreille.

It was, however, by the labours of Swammerdam and Réaumur that the generalizations of later workers became possible. Classification requires a more or less complete knowledge of external form, internal structure, and developmental history. So the teleology of the earlier writers, even of those of the present century, may appear to some of us as childish speculations. Yet the mechanical adaptation of means to ends was the touchstone, so to speak, of truth, even in my younger days. Evolution and the relations of organisms by descent were unknown factors amongst all but a few. Lamarck's arguments were regarded as atheistic, and were so strained that they carried no conviction. "The Vestiges of

Creation " attracted attention, but wanted detail, and was regarded by scientific men as no more than a clever essay.

It was not until the year 1859 that Natural History can be said to have entered into its present phase. It was Charles Darwin's great work, " The Origin of Species," which inaugurated the new era, and turned the thoughts of Biologists into new channels; it was through this, in my estimation, the grandest book on Natural History ever published, that the old methods of study gave place to the new. The fearless publication of " The Origin of Species " must be credited, to a great extent, with the rapid advances of the last three decades.

It may be that the construction of Hypothetical lines of descent, Phylogeny, which found exuberant development in the works of Professor Hæckel and his followers, are premature, but they replaced the old search for the one natural classification, the philosopher's stone of biology, which gave rise to such fanciful ideas as the ternary and quinary groups of Swainson and MacLeay; the circles within circles, a favourite puzzle to me when a mere lad, popular in their time, but perhaps quite unknown to many of the rising workers of the present day.

But to return from the long digression to the seventeenth century and Swammerdam. For one thing, I am sure you will all have an interest in him; he was the inventor of mounting objects in balsam. He soaked his insects in turpentine, and mounted them in balsam* to examine their more minute details of structure; and his drawings have been admired by all. It is said that he spent a month, working almost night and day, at the intestine of the hive-bee. That, at least, is evidence of the thoroughness of his work.

The next great epoch is marked by the appearance of De Réaumur's " Memoirs."

Réaumur was born at Rochelle, in 1683, and is known to us all by his thermometer. He also invented a process for making steel, for which the French Government gave him a pension. The chief work of his life was, however, his " Memoirs," published in 1738, and the investigations which led to them. His steel process is superseded, his thermometer is a mere scale which is little used now, but his " Memoirs " are immortal.

* " Detexerat, adipem cujusque Insecti dissolvi perfecte in Oleo Terebinthinæ, eoque facto balsamo condiri posse," from " The Life of Swammerdam," by Boerhaave. " Bybel der Natuure," p. 16, Edit. 1737.

In most things their accuracy is amazing, and they are full of details. He has recorded facts in the development of my old friend the fly, which even Weismann has neglected. Beside all this there is a freshness in his style which appeals to the mind, and a charming simplicity. He had an almost childish love for discovering new facts. I was reading the other day his account of the proboscis of the fly, and cannot forbear to quote to you what he says, for it is typical of the man who wrote four heavy quartos on insect anatomy. Réaumur gives a delightful description of the manner in which the fly feeds, and of the movements of the lips of the proboscis. He had noted that the insect regurgitates its food, that it ruminates, as he puts it. He adds, to make sure of this, "I fed a fly with some bright red gooseberry jelly, which appeared to suit its taste amazingly. When I thought it had had enough, I took it up gently between my thumb and finger to observe it at my leisure. Presently, to my delight, I saw the bright red fluid appear, and saw the insect suck it up again. I felt sure by its colour that it was the gooseberry jelly, but to make assurance sure I put my tongue to the proboscis of the insect and tasted it."

The next work to which I shall draw your attention is Lyonet's well-known "Anatomy of the Goat Moth Caterpillar." It was published in 1762, and is a masterpiece of research, and most beautifully illustrated by steel engravings. I fancy these engravings first excited me when a lad to work at the anatomy of insects.

In 1790 a work appeared at Nurnberg, which is by no means so well known; I allude to Gleichen's book on the common house fly. Wilhelm Friedrich Friherrn Gleichen, a very great man in Nurnberg, a possessor of the Grand Cross of the Red Eagle of Brandenburg, was the historian of our humble household pest. This work was most beautifully illustrated by one John Christopher Keller. It must be regarded rather as a life history and description of the external appearance of the fly than as an anatomical work; and I should not perhaps have mentioned it at all were it not for its antiquity and from its near relation to my own special study—the blow-fly.

In passing on I must draw your attention to Savigny's "Memoirs on Invertebrates." It appeared in Paris in 1816. Unfortunately it is a very incomplete publication, and does no justice to Savigny. It is not too much to say of Savigny that all the work which has been done on the mouth organs of insects was

initiated by this young savant. It is, however, chiefly through the writings of Cuvier and Latreille that we are acquainted with the work of Savigny. Perhaps he felt, to quote the words of a celebrated Italian, that research is "Il Paradiso, composition, Il Purgatore, and publication, Il Inferno." I know myself that I often feel the truth of those words, but after nearly thirty years of Il Paradiso I have at last made up my mind once more to risk the result, and give my researches to the world and I trust before very long, in the shape of an amended and very much amplified "Anatomy of the Blow-fly."

Perhaps by far the best monograph on the anatomy of any insect which has yet been written was published in Paris in 1828, Straus Durckheim's magnificent volume, "The Anatomy of the Cockchafer."

No one who has not studied the anatomy of an insect down to its most minute details can rightly appreciate the accurate detail of Straus Durckheim's work. It is chiefly valuable in relation to the hard parts of the integument, which we now term sclerites, but which have been compared by all the earlier writers to the bony skeleton of a vertebrate.

There is one point which has struck me as of special interest in relation to these sclerites, which are secondary indurations of the cutaneous membrane. It is their strange persistency in the most dissimilar types. This would not appear to me so extraordinary if they appeared at an early period in the development of the individual. But they do not, they appear at quite a late stage; yet in the complex thorax of the fly I have been able to identify every sclerite with the sclerites described by Straus Durckheim in the thorax of the cockchafer. Just as the bones of the skull can be compared in the most dissimilar types of the vertebrate, so the sclerites of the thorax, if sufficiently carefully studied, can be compared in the most dissimilar types of insects; at least in those which undergo a complete metamorphosis. If I dare to generalize at all with regard to the relations of different insects from a phylogenic point of view, it would be to assume that there is evidence that similar sclerites have been formed independently by parallel lines of descent from a common ancestral form in which they were undifferentiated—at least admitting the theory of descent from common and simple ancestors, that is the conclusion to which my researches irresistibly tend.

Whilst speaking of the sclerites I cannot omit to mention two very remarkable papers in the Acta of the Turin Academy, by Dr. L. Jurine, on the " Wings of the Hymenoptera," published in 1828, the year in which Straus Durckheim's immortal Monograph saw the light. Dr. Jurine worked out the structure of the wings, and my own work shows the close correspondence between the wings of the Diptera and the anterior wings of the Hymenoptera. Straus Durckheim, although most eminent as an observer, was less fortunate, I think, in his generalizations, and the theory which he invented, and which is generally held with regard to the mechanism of flight in insects, appears to me to be utterly untrue. I cannot, however, now enter into the details of the mechanism, which is far more complex than Straus Durckheim supposed. And Dr. Jurine, although he has very carefully described the more important sclerites of the wing, did little to elucidate the mechanical problem involved in flight.

So far I have not had the pleasure of mentioning a single English work on the anatomy of insects, and our literature, it must be confessed, is very meagre on this subject. We never had a Swammerdam, a Réaumur, a Lyonet, or a Straus Durckheim.

The first English work of any note which I can mention is a mere translation, W. E. Shuckard's translation of Herman Burmeister's Manual of Entomology, with additions by the author and original notes by the translator, published in London in 1836—an excellent text-book at the time, but rather old now.

There are two Englishmen, however, whose names must not be omitted, although they were not specialists, and left no work on insect anatomy to be compared with those which I have quoted.

The first of these was Dr. Harvey, the discoverer of the circulation of the blood. Harvey was an accomplished naturalist, and had original and, in the main, correct ideas, with regard to the metamorphoses of insects. I shall have to recur to Harvey when I come to speak of one of the greatest, if not the greatest, of living discoverers in this branch of natural history. I allude, of course, to Dr. A. Weismann.

The other was John Hunter, who always observed and recorded, and the reader of Hunter's works will find many admirable observations in insect anatomy.

Before I conclude this portion of my address I would draw attention to what I consider far the best English account of the general

anatomy of insects. It is undoubtedly G. Newport's article "Insecta," in Todd's "Cyclopædia of Anatomy and Physiology," published in 1836-9.

Newport was not a mere compiler of the work of others; he was a careful and painstaking anatomist, and where he differs from his predecessors, so far as I am a judge, he was almost invariably right. Every student should carefully peruse this article. Amongst more modern works on insect anatomy I may mention my own work on the blowfly, written, I may say, prematurely, when I was young, published in 1870; Dr. Karl Kræpelin's admirable paper on the proboscis of the same insect, published in Kölliker's "Zeitschrift" in 1883, by far the most complete and accurate description yet published on a subject which has an enormous literature; and, lastly, Messrs. Miall and Denny's work on the cockroach, published in 1886, a work which is professedly elementary, but, as far as it goes, eminently satisfactory and necessary to every student who wishes to undertake entomotomy.

So far I have confined my attention to works on the subject of insect anatomy which are either general or are monographs on some special insect. Let us now take a glance at the advances which have been made with regard to the anatomy of the sensory and nervous structures and the physiology of insects.

This branch of our subject took its origin more especially from the researches of Johannes Müller, who published a work on the comparative physiology of vision ("Zur Vergleichenden Physiologie des Gesichtssinnes) in 1826, a work which has now become classical. We must remember that Müller had very indifferent means of research at his disposal. Microscopes in 1826 were ill adapted for difficult problems, and the modes of preparing objects for observation were nearly as primitive as in the days of Swammerdam. With all its faults and optical impossibilities, Müller's theory of the manner in which the compound eye subserves its function, although repeatedly attacked, has even at the present day a strong hold on many minds.

Gottsche in 1852 first seriously attacked Müller's theory, and showed the subcorneal images. Although these were known to Leeuwenhoek, attention had not been drawn to them in relation to Müller's theory of "Mosaic vision."

Since that date the compound eye has been a battle-field with entomotomists. Claparède gave the first fairly complete descrip-

tion of the structure of these marvellous organs in a well-known paper in Kölliker's "Zeitschrift" about 1857; and he did more, for he investigated the development of the compound eye at a time when next to nothing was known about the development of special organs in insects. The number of papers which have since appeared is very great. As you all know, I am myself fighting the question, and I believe that my views,* which are optically and physiologically tenable, and which are based on anatomical facts, demonstrated by slides, admitted by the best judges to be far more perfect than any others which have been exhibited, and by photographs made by our old friend Mr. Nelson, are in a fair way to be accepted by the leading English biologists. I may also say that I am told that Professor S. Exner of Vienna, has lately demonstrated an optical picture in the entire compound eye, which corresponds to the surface of my retina. If this is so, and I am only waiting for the return of more genial weather and living insects to make the experiment, my views cannot fail to be generally accepted without further delay.

Amongst those who have attempted to make experiments for the purpose of discovering the functions of the organs in insects I would mention M. Faivre's experiments on the nervous system of dytiscus in 1857, Sir John Lubbock's interesting experiments on the Hymenoptera published in the Journal of the Linnean Society, and the long series of experiments which have been carried on for fifteen or twenty years by Professor Plateau, of Ghent—records of which I still receive from time to time from their learned author. We all feel that such experiments are greatly needed, but at the same time regret that, owing to the complexity of the phenomena observed, we are still very much in the dark with regard to the manner in which the various functions are carried on, and with regard to the correct interpretation of the phenomena observed. The subject is still further rendered obscure by the difficulties which arise from the testimony of different observers being somewhat contradictory.

The organs in insects to which we must probably ascribe the function of ears are very unlike the auditory organs of vertebrates. Our knowledge of these structures is pre-eminently due to the elaborate researches and splendid papers of Professor Vitus Graber,

* "Linn. Trans.," Ser. ii., "Zoology," Vol. ii., 1884.

who has spent years in the research, and who published an almost exhaustive treatise in the Vienna "Denkschriften" in 1876 on these organs in the Orthoptera.

The auditory organs in insects are clearly related to the tracheal system, and it is a remarkable fact that their locality is very variable; thus in the locust and the green grasshoppers they are on the anterior tibiæ; in some field crickets (*Acridioidæ*) they are on the first abdominal segment near the back. I may announce that I have discovered a most perfect ear, similar in all respects to that of these field crickets, in the fly, except that it is on the mesothorax. I trust soon to publish a full account of this organ. There is also a drum similar to the drum of the cicads and the field crickets (*Grylloidæ*) which in these insects produces the sounds they emit; this drum is in close proximity to the ear.

The sensory nerve terminals of the auditory nerves in the fly are identical with the so-called chordotonal organs which serve this function in the Orthoptera. Whilst speaking of Dr. Graber's discoveries in relation to the auditory organ I take the opportunity of mentioning that he has published a little book on insects—"Die Insekten," Munich, 1877—which, for those who read German, is far the best and most complete account of the anatomy and development of insects ever published in a popular form, and that the work gives a complete *résumé* of all the more important recent discoveries. It is a charming little work on insect anatomy and development, quite up to the date of its publication.

It is only recently that the intimate structure of the central nervous system has received any attention. Till lately it was considered that the ganglia of the thorax and of the head have a similar value and structure, and insects were spoken of as "homogangliate."

Dietl in 1876 first examined the brain in serial sections, and investigated the nature of certain convoluted pedunculated organs which Dujardin had called attention to, in bees and ants, a quarter of a century before. Flögel took up the subject about the same time, and invented a nomenclature for the parts, which he described accurately. I believe, with certain modifications, Flögel's nomenclature is very unlikely to be superseded. Flögel's paper appeared in 1877, and was immediately followed by a paper from the pen of Emil Berger, less satisfactory, however, than Flögel's, and a year later by E. T. Newton's papers on the brain of the cockroach,

one of which is published in your Proceedings. Newton did good service by his English rendering of Flögel's nomenclature.

The most important contribution to our knowledge on this subject which has been published in the English language is Packard's "Monograph on the Brain of the Rocky Mountain Locust," in the United States Entomological Commissions' Report for 1880, and by far the most detailed and recent work is that of Dr. H. Viallanes on the brains of the wasp and cricket in the "Annals de Sciences Naturelles" for 1887 and 1888.

It is now usual to speak of the cephalic nerve centres of insects as the brain, but all those who have written upon the subject have retained the old view that this structure consists of several ganglia corresponding to a similar segmentation of the head. Thus we find discussions as to the number and relations of the prestomal ganglia and segments.

The theory of segmentation was formerly applied to the vertebrate skull, and originated in the brains of Oken and Goethe. Professor Huxley, in his lectures on the vertebrate skull published in London in 1864, disposed for ever, I believe, of these views, and showed clearly that the skull is developed from parts which do not undergo segmentation. My own researches in the embryology of insects have sufficiently shown me that the brain and head capsule of insects are also developed from structures, the procephalic lobes of Huxley, which undergo no segmentation. I am indeed convinced that there are no prestomal segments in insects.

Viewed in relation to development, the brain in insects consists of a central ventricle and two hemispheres, which are themselves hollow. The central ventricle contains a transverse and longitudinal commissure, the corpus centrale, and is connected by its posterior wall with the median eyes or ocelli. There is thus a close correspondence between the brains of vertebrates and those of insects. The so-called antennal lobes correspond to the olfactory bulbs, the central ventricle to the third ventricle, and the ocelli to the pineal gland or pineal eye where the latter is developed. The hemispheres are cerebral lobes, and the pedunculated bodies are merely isolated convolutions of the surface. My unpublished work on this subject will occupy some thirty closely-printed pages at least.

The last subject in connection with the anatomy of insects to which I shall draw your attention is perhaps the most interesting and important of all—the history of the development of the indi-

vidual. The great writers of the past, Swammerdam and Réaumur, exercised the greatest ingenuity and patience in the attempt to solve the problem, but the present state of our knowledge is a modern development. It is true that Rathke's beautiful and classical work on the development of the crayfish was published as early as 1829, but Zaddach's paper on the development of the eggs of the Caddis flies, published in Berlin in 1854, is the first great work with which I am acquainted on insect development in the egg. Since that date the literature on this subject has literally flooded us. Brandt in his treatise on the development of the egg gives over 200 references to papers more or less directly connected with the subject in 1878. I will only refer to the latest discovery in the embryology of insects in the egg, because I feel a personal interest in it.

Until quite recently the formation of the mesenteron or central segment of the alimentary canal was supposed to be quite exceptional in insects. No one had ever seen the invagination of the hypoblast or the blastopore. Last summer I was fortunate enough to cut a longitudinal section of an embryo which showed that the hypoblast is formed by invagination, and I had prepared a paper on the subject when I received the current number of the "Zoologische Anzeiger," and found a note by Bütschli with a figure exactly representing the formation of the mesenteron as I had seen it in my section.

Although, perhaps, in a morphological sense, the development of the embryo in the egg is the more important, the after-development of insects in the pupa and more especially that in the fly, is the more interesting, from its very extraordinary and exceptional character.

Harvey, whom I have already alluded to, made a remarkable generalization with regard to the pupa in insects. He seems to have had an intuition which enabled him to predict modern discovery. For him the eggs of insects had not a sufficiency of nutriment, so that the embryo quits the egg in an imperfect state, and when it has obtained a sufficiency, returns to the state of the egg, *i.e.*, the pupa is this second egg in which the perfect insect is developed and in it we find a secondary yelk.

It was, however, Dr. A. Weismann who first described in detail the manner in which this extraordinary process occurs, in 1863 in his "After-development of the Diptera."

When we remember the primitive modes of histological research which were then in use, and the unsettled state of men's minds with regard to the manner in which the various tissues are developed, we must regard this paper of Weismann's as one of the most wonderful, if not the most wonderful, record of brilliant discovery which has appeared in our lifetime. The whole of it reads almost like a fairy tale, and yet, from my own personal work, I can verify all the main facts as set forth by this great German biologist. Swammerdam and Réaumur observed certain swellings on the nerves of the dipterous larva which they believed to be ganglia. Weismann discovered that these are the germs from which the imago is developed, and observed the manner in which they unfold and become united to each other during the development of the nymph within the pupa case.

Weismann made mistakes undoubtedly, but these do not detract from the greatness of his discoveries. It would be as reasonable to take the credit of the discovery of America from Columbus, because he supposed it to be a part of Asia, as to detract from Weismann's masterly work because the discoveries of the last twenty years were not all made by him.

Weismann named the rudimentary structures from which the perfect fly is developed "imaginal discs." He traced the development of the head from two such discs and that of the thorax from twelve. He believed that the abdomen is formed from that of the larva; and supposed that the tissues of the fly are developed from the ruins of those of the larva, by a process of free cell formation.

This process, which has some analogy with the spontaneous generation, is certainly a myth, but Weismann had no means of accurately examining the discs—section cutting was unknown—and he made his observations by rendering the tissues transparent with various reagents. So thick were the masses on which he operated that, like Swammerdam, he had recourse to direct sunlight for the illumination of his objects, and so persistent was his work that I am informed he nearly blinded himself.

It was Ganin who first determined the fact, unknown to Weismann, that these imaginal discs consist of mesoblast as well as epiblast, and that not only the integument, but all the tissues of the perfect insect, originate from them.

Ganin also discovered the fact, that the abdomen of the perfect insect, as well as the alimentary canal, is developed like the head

and thorax from imaginal discs. He also traced these discs to their origin, the larval tissues to which they correspond.

Dewitz in 1878* showed that the process of development in the Hymenoptera and Lepidoptera is not unlike that in the Diptera, so that we must regard the imaginal discs as capsules of reserve, developed in relation with the same embryonic structures which they are destined to represent in the imago, or, as fragments of the original blastoderm to be nourished by a new yelk, formed by the disintegration of the larval tissues.

The manner in which this disintegration is brought about has been the subject of careful investigation, and in this relation I must again refer to the excellent work of Dr. Viallanes. The record of this work will be found in Vol. xiv. of the 6th series of the "Ann. Sc. Nat. Zool.," published in 1882. Nearly the whole volume is occupied by his elaborate paper. Dr. Viallanes has there recorded a vast number of facts connected with the development, structure, and disintegration of the larval tissues. He calls this process of disintegration "histolysis"; he also did much to elucidate the manner in which the new tissues of the imago are developed. With regard to the true nature of this histolysis, by which a new nutrient yelk originates in the pupa, Viallane's observations apparently led him from the main process, which he did not discover.

D. Barfurth in 1882† investigated the process of absorption which occurs in the tail of the tadpole, and discovered that the tissues are invaded by protoplasmic amæboid cells, white blood corpuscles or lymph corpuscles, and that these, which he terms phagocytes, are the main agents in their disintegration. That such processes occur in the development of bone had long been known, and that phagocytes are important agents in morbid processes has long been suspected. In 1883 Metschnikoff published a paper on this subject, and within the last few months Kowalevski, of Odessa, one of the most successful and brilliant living biologists, has published an extensive series of investigations on the after-development of the blow-fly, in which he clearly shows that the disintegration of the larval tissues is mainly due to their invasion by phagocytes.‡

* "Zeits. f. w. Zool.," Bd. xxx., Sup.
† "Archiv. f. Mic. Anat.," Bd. xxix
‡ "Zeits. f. w. Zool.,' Bd. xlv.

For several years I have been working at this subject, and long ago I saw the phagocytes invading the muscles of the larva. I can entirely confirm all Kowalevski's observations, both with regard to the histolysis of the larval tissues and the development of the alimentary canal of the imago. In some few points, however, I think it probable that my ultimate conclusions may differ from his. I am, however, now engaged in revising this portion of my forthcoming work by the light of Kowalevski's discoveries.

In this address I have only touched upon many points, and I have only mentioned some of those works which appear to me to occupy the first place. I have of necessity passed over many important papers in silence. I have at present nearly three hundred slips of reference to various papers on insect anatomy, physiology, and development, most of which I have read, some few I have still to read. There is one work, however, which I would refer to before I conclude. It is M. Kunkel de Herculais' splendid, but unfortunately unfinished, monograph on the Genus Volucella. The plates are most beautiful, and it is greatly to be regretted that the letterpress was never completed. It was published in Paris in 1875, in parts, the plates preceding the letterpress. I know of no drawing representing any insect structure on so large a scale with such accuracy of detail as M. Kunkel's plate of the proboscis of Volucella.

I cannot conclude this somewhat technical address without thanking you for re-electing me as your President, and also for the manner in which the Quekett Club have always received everything which I have brought before them. My earliest publications were in your Journal, and the encouragement and support of the Club has been a valuable aid to me on many occasions.

Some critical remarks by Herr A. Grunow on the Oamaru Diatom papers of Messrs. Grove and Sturt.

Translated by G. C. Karop, *with Annotations by* E. Grove.

Introduction.

The papers on the fossil marine Diatomaceous deposit of Oamaru, New Zealand, which appeared in this Journal, Ser. II., Vol. ii., p. 321, and Ser. II., Vol. iii., pp. 7, 63, and 131, by Messrs. Grove and Sturt, having been reviewed by Herr Grunow at considerable length in the "Botanisches Centralblatt," No. 31, 1887, and Nos. 15, 16, 1888, it has been thought desirable to put before the members the following summary of such of Herr Grunow's remarks in the "Centralblatt" (as well as in correspondence with Mr. Grove), as have reference to changes or modifications in the names given to any of the forms by the authors.

Summary.

Pseudo-rutilaria monile, Gr. and St. Is not at all related to Rutilaria, but closely allied to several species of Hemiaulus.

Cerataulus subangulatus, Gr. and St. This very peculiar Triceratium-like form can hardly be classed with Cerataulus. [The texture of the valve, form of processes, and presence of spines (which are occasionally forked like those of *C. turgidus*), induced the authors to place this in Cerataulus rather than add to the number of existing Genera. The subangular outline is not of specific importance.—*E. G.*]

Triceratium parallelum var. gibbosa, Gr. and St. Agrees better with the nearly related *Tr. disciforme*, Grev. [This form agrees more closely with the figures of *Tr. parallelum forma trigona*, in Plates LXXV. and LXXVI. of "Schmidt's Atlas," than with the figure of *Tr. disciforme*, Grev., in Pl. LXXV. This and similar angular forms are now rightly placed in Stictodiscus, and in the Atlas, Pl. CXXXI., Fig. 9, is an excellent drawing of this Oamaru form under the title of *S. parallelus*,

forma gibbosa, of which title, from the reference to Herr Grunow in the text, it would appear that he now approves.—*E. G.*]

Tr. spinosum var. ornata, Gr. and St. A very different species to *Tr. spinosum*, and may be named *Tr.* (*Ornatum*, Shadb. var. ?) *fallaciosum*, Grun.

Tr. venulosum var. major, Gr. and St. Also a distinct species. [The authors have agreed to adopt the specific name of *Tr. majus* for this, under which it is figured in Atl. Pl. CXXVII., Fig. 1. Fig. 3 in the same Plate, named *Tr. venulosum*, var ?, and also very frequent in the Oamaru deposit, differs but slightly.—*E. G.*]

Tr. Dobreeanum, Grev., *var. Nova Zealandica*, Gr. and St. Does not agree with *Tr. Dobreeanum*, but is closely allied to *Tr. lineolatum*, Grev. Very variable, with sides from 0·08 to 0·42 mm. [This is distinct enough to justify the specific name of *Tr. Nova Zealandica*, Gr. and St.—*E. G.*]

Tr. crenulatum forma gibbosa, Gr. and St., should be *Tr. undatum*, Grun. [Gibbous forms of *Tr. crenulatum* are common in the deposit, but the form figured by the authors in Part 2, Pl. II., Fig. 4, is no doubt a distinct species, and is rightly distinguished by Herr Grunow as *Tr. undatum.*—*E. G.*]

Tr. capitatum (Ralfs ? ?), Gr. and St., should be *Tr.* (*capitatum*, Ralfs, var. ? ?) *castelliferum*, Grun. [The form figured under this name in Atl. Pl. CXXVIII., Figs. 17, 18, is that which the authors included in the list as *Tr. trisulcum*, Bail. (Pt. 4, p. 8). The species which they named *Tr. capitatum*, Grev. (Pt. 1, p. 6), is given in Fig. 19 as *Tr. glandarium*, A. Sch.—*E. G.*]

Tr. castellatum, West. Mostly occurs with a small, sharply marked, punctated space at the angles, which Herr Grunow designates var. *fracta*, as it is, perhaps, identical with *Tr. fractum*, Walker and Chase.

Tr. Morlandii, Gr. and St. Herr Grunow proposes to add var. *sub-aperta*, Grun., for varieties in which the ring of meshes round the centre is more or less incomplete in three places. Such forms greatly resemble *Entogonia davyana*, Gr. and St. (nec. Grev.), which Herr Grunow provisionally designates var. *aperta*.

Tr. Grayii, Gr. and St., in literis, instead of *Tr. barbadense*, Gr. and St., nec. Grev.

Tr. plenum, Gr. and St., in literis, instead of *Tr. Weissflogii*, which name was adopted shortly before by Messrs. Walker and

Chase for a distinct species. Herr Grunow considers that this stands very near to *Tr. repletum*, Grev.

Aulacodiscus Sollittianus, Norm., *var. Nova Zealandica*, Gr. and St. Differs widely from *A. Sollitianus* by its broad, finely punctated margin, and by nearly always having three (very rarely two or four) processes. [The authors view of this as a var. of *A. Sollittianus* is accepted by Mr. Rattray in his monograph on the genus Aulacodiscus ("Jour. Roy. Micros. Soc.," June, 1888, p. 377). It is figured in the "Atlas" (Pl. CXXIV., Fig. 8) as *A. nova-zealandicus*, Gr. and St.*—*E. G.*]

Eunotogramma productum, Gr. and St., in literis, instead of *E. weissii*, var. *producta*, Gr. and St.

Eunotia striata (Gr. and St.), Grun., instead of *Euodia striata*, Gr. and St.

Amphiprora ? ? cornuta, Chase. Not a diatom.

Nitzschia Groveii, Grun., instead of *Amphiprora rugosa* (Petit ?), Gr. and St.

Synedra Groveii, Grun., instead of *S. crystallina*, G. and St., nec. Kg.

Amphora Sturtii, Grun. (*A. contracta, ?* Gr. and St., nec. Grun.). Differs from *A. contracta* in its well-marked costæ and curved raphe dividing the striæ.

Navicula hochstetteri, Grun., Alg. Novar., instead of *N. placita*, Gr. and St.

Navicula spathifera, Gr. and St., in literis, instead of *N. lobata*, Gr. and St., that name having been given to a distinct species by Schwartz.

Grammatophora oceanica, Ehb. This does not seem to occur in the Oamaru deposit, but another form closely allied to *G. insignis*, Grun., which Herr Grunow proposes to call *G. Oamaruensis*.

Gephyria incurvata, Arnott. The older name for this, and therefore to be preferred, is *Entopyla australis*, Ehr. Herr Grunow has not met with this, but a form having much narrower valves, which he names var. *Oamaruensis*. He has also seen another species with broad elliptical valves, which he will describe elsewhere.

Isthmia enervis, Ehr. Besides the type form, another occurs

* Schmidt remarks that it would be more grammatically correct if this were altered to *A. Novæ Zealandiæ*.

rarely with traces of costæ, which Herr Grunow calls *I. intermedia*. There is yet a third form with delicate markings and a long, obliquely truncated process, suggestive of *Hemiaulus tenuicornis*, Grev. For this, which is not rare, Herr Grunow proposes the provisional title *Isthmia ? tenuicornis*, unless perhaps it should be placed in a special genus.

Hemiaulus ? tenuicornis, Grev. Differs in marking from the Barbadoes type, and, if not a separate species, should, at least, be designated var. *Novæ Zealandiæ*.

Glyphodiscus scintillans, A. Schm. Herr Grunow has noticed several examples, up to 0·1 mm., with as many as 15 marginal spots. They differed from Schmidt's figure by having small punctæ (spines ?), one between each two marginal spots. The structure of the valve was also different, being covered, in addition to the short, irregular, radial markings, with a network of irregular meshes. He calls this form *Eupodiscus Oamaruensis*, not having met with the true *Gl. scintillans* of the Nicobar earth in the Oamaru deposit.

[*Eupodiscus Oamaruensis*, Grun., has been placed by Mr. Rattray in a new genus, *Debya* ("Jour. Roy. Micros. Soc.," Dec., 1888, p. 909), but that name having been previously adopted by Dr. Pantocsek for a different generic form, Mr. Rattray has since given the MS. title of Aporidiscus to the genus. In the meantime Dr. Toni has published the designation "Rattrayella" for the same, which appears in "Notarisia," January, 1889, p. 691.—*E. G.*]

Eupodiscus Debyii, Gr. and St., in literis (*Lampriscus Debyii*, Gr. and St.), is certainly not a *Lampriscus*, and can hardly be classed with *Eupodiscus*, but should, perhaps, be placed in a new genus.

[This form is now *Isodiscus Debyii*, Rattray ("Jour. Roy. Micros. Soc.," Dec., 1888, p. 920).—*E. G.*]

Cosmiodiscus Normanianus, Grev. Differs greatly from Greville's figure, and is probably a new species.

Brightwellia pulchra, Grun. Herr Grunow is now doubtful whether this form can be separated from *B. coronata*, Grev.

Stephanogonia Nova Zealandica, Grun. (*St. Danica*, Gr. and St., nec. Grun.). Differs greatly from *St. Danica*, by the absence of punctation.

Biddulphia pedalis, Gr. and St. In the proposed separation

of Biddulphia and Odontella by Herr Grunow, this would, in his opinion, belong to the latter.

Biddulphia? fossa, Gr. and St. Appears to be *Anaulus*.

Syndetoneis amplectans (Gr. and St.), Grun. (*Hemiaulus amplectans*, Gr. and St.) Not *Hemiaulus*.

Coscinodiscus spiniferus, Gr. and St., in literis, instead of *C. elegans*, var. *spinifera*, Gr. and St., olim. Herr Grunow thinks it is more nearly related to *Cestodiscus pulchellus* than to *Coscinodiscus elegans*.

Stictodiscus nitidus, Gr. and St., in literis, instead of *St. californicus*, var. *nitida*, Gr. and St.

Actinoptychus (*glabratus var.*) *elegantulus*, Gr. and St. Is at any rate a distinct species.

A. tener, Gr. and St., in literis, instead of *A. pulchellus*, var. *tenera*, Gr. and St.

PROCEEDINGS.

NOTE.—In the discussion following Mr. Morland's paper on "Mounting Diatoms," printed on p. 351, some statements are made regarding the procedure of Dr. Gray which require qualification or correction. The first use of the cow's bristle for selection should be attributed to Mr. Hardman. As to Dr. Gray's not employing the breathing process, it was meant that he did not now use any *mechanical appliance* for the purpose. For mounting media Dr. Gray uses either undiluted *balsam* or, preferably, styrax, first dried by heat and then dissolved in benzole.

DECEMBER 14TH, 1888.—CONVERSATIONAL MEETING.

The following objects were exhibited :—

Amphipleura pellucida, under a cheap $\frac{1}{12}$ oil imm. O.G.	Mr. C. Lees Curties.
Pulex penetrans, ♀	Mr. T. Curties.
Retina of eye of Tadpole	Mr. H. E. Freeman.
Section of eye of Dragon Fly	Mr. G. E. Mainland.
Coscinodiscus spiniferus	Mr. H. Morland.
Stephanoceros Eichhornii...	Mr. C. Rousselet.
Melicerta tyro	"
Pleurosigma angulatum	Mr. T. F. Smith.

Mr H. Epps also exhibited a method of illuminating through solid glass rods.

Attendance—Members, 26; Visitors, 2.

DECEMBER 28TH, 1888.—ORDINARY MEETING.

Prof. B. T. LOWNE, F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

The following gentlemen were balloted for and duly elected members of the Club :—Mr. Charles Whitehead, Mr. Charles Henry Ogden, and Mr. Arthur H. Smith.

The following donations to the Library were announced :—

"Proceedings of the New York Microscopical Society"	In Exchange.
"The American Monthly Microscopical Journal" ...	"
"Proceedings of the Royal Society of New South Wales"	"
"Proceedings of the Hertfordshire Natural History Society	"
"Journal of the Liverpool Science Students' Association"	"
"The Botanical Gazette"	"

Three slides from Mr. McIntire in illustration of his paper.

Mr. Rousselet's paper, "On a New Rotifer," was read by the Secretary, and the thanks of the meeting were voted to the author.

Mr. S. J. McIntire read a paper entitled "Further Notes on Some Coccids from British Guiana," the subject being illustrated by drawings and by specimens shown under the microscope.

Mr. Goodwin thought it would be a good plan if the number of the slides illustrative of a paper could be mentioned in the paper, so that anyone reading it could at once obtain them from the cabinet if he desired them for comparison by asking for them by their number.

Mr. Hailes thought there was a little practical difficulty in the way of doing this in all cases, but as the slides were always duly entered as soon as received there would be no trouble in finding them at once by reference to the catalogue on the table.

Mr. Michael said that Prof. Riley and others of the American State Naturalists had written much upon this subject, and it would seem to be the fact that, whilst naturalists were actively engaged upon the subject, the gardeners were not equally ready to profit by what had been written for their instruction. In the Missouri Reports they would find enough upon the subject to fill a large book. The matter had claimed great attention there on account of the damage done by the scale blight to the apple and other trees, and the consequent inquiries for remedies.

Mr. R. T. Lewis detailed a series of observations upon the larval forms of two species of Coccidæ from Natal, the subject being illustrated by drawings and by the exhibition of both living and mounted specimens shown under microscopes in the room.

Mr. Michael inquired if any specimens of the male insect had been found, it being extremely desirable to find it in order to correctly determine the species?

Mr. Lewis said he had not yet been able to find one. He had, however, some hope of doing so in the case of *Icerya*, and intended for that purpose to carefully sort over the *débris* in the box containing these insects. All the adult specimens yet examined were certainly females, and the numerous larvæ recently hatched appeared to be all alike.

The President said he had been exceedingly interested by the papers brought before the meeting that evening. The subject of the Coccidæ was one which he had often thought he should like to study, but he had been prevented from doing so by the knowledge of the enormous amount of time and patience which it would take to follow it out thoroughly. All three of the papers that evening had been very valuable from a zoological point of view, and were certainly from that point amongst the best they had had for some time. It was papers of this kind that they wanted more of, not merely for the information they contained, but for the evidence they afforded of the work that was being done by the members of the Club.

The thanks of the Club were voted to Messrs. Rousselet, McIntire, and Lewis for their papers.

Mr. E. M. Nelson said he should like to call attention to rather a useful piece of apparatus manufactured by Zeiss, which was certainly the best

pocket lens he had ever used. It had a large field, and, being aplanatic, was a thing so useful to every microscopist that it deserved to be brought more into notice. It was made in two sizes, one of which gave a magnifying power of six diameters and the other ten. As a condenser for low powers it was admirable, and was easily used if put into a piece of brass made to fit below the stage.

Mr. Karop said that the mention of Dr. Zeiss's name reminded him that his death had occurred since their last meeting—not, it could be said, before his time, for he had reached a good old age. He was one of the best-known makers of microscopes in the world.

The President said with regard to the lenses mentioned by Mr. Nelson he had found them of very great use for a variety of purposes; indeed, there were no lenses which he knew of that were so comfortable to work with.

Mr. Karop said that as to using a lens of this sort as a condenser no doubt it could be adapted to the purpose, but unfortunately the cheap microscopes of the present day were not centred with sufficient accuracy to make a condenser of much use. The adapter was screwed by rule of thumb under the stage, and was generally dreadfully out of true centre. He thought that when a sum, say, of £5, was given for a student's stand *without objectives* it should *always* be furnished with some kind of centring adapter below the stage to carry a condenser, as this most necessary appliance for good work was practically useless unless properly centred, and he had rarely, if ever, found the ordinary sub-stage tube anywhere near central with the optic axis.

The Secretary reminded the members that as their next meeting was the one which preceded the annual meeting it would be necessary then to nominate persons to serve as officers and members of Committee for the ensuing year, in view of the election which would take place in February.

Announcements of meetings, etc., for the ensuing month were then made, it being intimated that at the next ordinary meeting a paper would be read by the President on " Diffraction Phenomena."

The proceedings terminated with the usual Conversazione, and the following objects were exhibited :—

Circulation of blood in egg and spawn of Trout	Mr. F. W. Andrew.
Section of the eye of a Moth	Mr. H. E. Freeman.
Larvæ of *Ortonia*	Mr. R. T. Lewis.
,, *Icerya* (living)	,,
Gemmules of Sponge, *Geodia*	Mr. G. E. Mainland.
Pulex penetrans ♀, in skin	Mr. F. W. Ward.
Corneal corpuscles of Pig, stained	,,

Attendance—Members, 33; Visitor, 1.

January 11th, 1889.—Conversational Meeting.

The following objects were exhibited :—

Ovum of *Trachelius*	Mr. F. W. Andrew.
Smynthurus aquaticus	Mr. E. T. Browne.

Elytron of Indian Tortoise Beetle, *Platypria echidna*	Mr. F. Enock.
Sand, showing radiating crystallization	Mr. G. C. Karop.
Semistellus nigripes, parasite of Hessian Fly ...	Mr. G. E. Mainland.
Eupodiscus argus	Mr. H. Morland.
Vertebra of Human Fœtus (2mo.)	Mr. W. Watson.

Mr. E. M. Nelson also exhibited, with the aid of a lantern, some photomicrographs illustrating diatom structure.

Attendance —Members, 37 ; Visitors, 2.

January 25th, 1889.—Ordinary Meeting.

B. T. Lowne, Esq., F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Henry Stocks was balloted for and duly elected a member of the Club.

Mr. A. Ashe, Roman Villa, Laurie Square, Romford, was proposed for election.

The following additions to the Library and Cabinent were announced: -

"Proceedings of the Royal Society"	In Exchange.
"Journal of the Postal Microscopical Society"	,,
"American Monthly Microscopical Journal"	,,
"Science Gossip"	,,
"The Botanical Gazette"	,,
"Annals of Natural History"	Purchased.
"Quarterly Journal of Microscopical Science"	,,
"Challenger Reports," Vol. xxix.	,,
Two slides of the larval forms of *Ortonia* and *Icerya*, in illustration of a paper read at the last meeting	From Mr. R. T. Lewis.

The Secretary thought it would be well to let the members know that they were probably holding the last meeting of the Club in that room—not that the College authorities were by any means dissatisfied with the use that had been made of it, but on account of the reports from the Librarian as to the extensive damage occasioned to the books by the gas. Another room downstairs had been placed at their disposal by the Council, which, he thought, would be found to answer all practical purposes as a meeting place, and would, probably, be found superior to the Library as regarded its acoustic properties, and the greater facility with which those attending could see the black-board or other means of illustration.

The Secretary reminded the members that their next ordinary meeting would be the annual meeting, and that it would, therefore, be necessary, according to the rules, to nominate Officers and Committee for the ensuing year. The names of Officers recommended by the Committee were as follows :—

President—Professor B. T. Lowne. Vice-Presidents—Messrs. Michael, Stewart, Newton, and Nelson. Other Officers as before. Also as Auditor on behalf of the Committee—Mr W. Hainworth.

The members were then asked to nominate another Auditor on behalf of the Club. Also gentlemen to fill vacancies upon the Committee, caused by the retirement of Messrs. Reeves, Dadswell, Stokes, and Morland, in accordance with the rules.

The following nominations were then made :—

As Members of Committee.

Mr. Morland,	proposed by	Mr. Parsons,	seconded by	Mr. Kern.
Mr. Dadswell,	,,	Mr. Ingpen,	,,	Mr. Morland.
Mr. Rousselet,	,,	Mr. Freeman,	,,	Mr. Stokes.
Mr. Reeves,	,,	Mr. Reed,	,,	Mr. Ward.
Mr. Stokes,	,,	Mr. McIntire,	,,	Mr. Goodwin.
Mr. Jas. Spencer,	,,	Mr. Morland,	,,	Mr. Burton.

As Auditor on behalf of the Club.

Mr F. H. P. Hind was proposed by Mr. Epps and seconded by Mr. Goodwin.

On putting the last proposal to the meeting, the President declared Mr. Hind to be duly elected.

Mr. S. J. McIntire exhibited and described a new collecting box designed by Mr. E. T. Browne.

Mr. Karop said he was not a collector, but he thought that though the box before them was good in design, it was a little too large, and when full it would weigh about fourteen pounds. He imagined that that would be found a considerable load where it had to be carried about over hill and dale on a hot summer's day. It also struck him that it could not be necessary to provide for the large quantity of material which could be stored there, because it was a matter of common experience that when such an enormous number of organisms were collected not a tithe of them could be used.

Mr. Parsons thought this was a step in the right direction, and as he generally carried such a lot himself he did not think so much about the size. This case seemed almost to carry out an idea which he had in his mind of getting a bag to open at the side in such a way that he could get at what was wanted without having to open the whole thing out. This box had the great merits of there being no waste of space, and of allowing the contents to be easily got at.

Mr. Rousselet said that for his own use he should prefer to have fewer bottles, but also larger ones. He did not think they wanted a net for condensing if afterwards they had to condense again. The weight was also a matter of importance, and he thought the weight of a bag would be less than that of the box before them.

Mr. Ingpen preferred large bottles to small ones, and to distribute them as much as possible in the pockets of coats and overcoats; and thought that they were less cumbersome to carry in this way than if they were all put together in one box.

Mr. Epps thought the space at the top of the box was unnecessary, and

that if the cover were made with sloping flaps a reduction in size could be effected without altering the capacity.

Mr. Karop thought the members of the Club who heard a paper read there some time ago by Mr. Underhill, upon "Spiders," would be glad to know that it was now published in the "Journal of the Postal Microscopical Society."

The President read a paper "On Diffraction Phenomena," the subject being freely illustrated by drawings on the black-board.

Mr. Ingpen regarded the President's paper as a valuable contribution to the literature relating to those optical principles the knowledge of which was essential to microscopists, and he hoped that it would be followed by others treating in a simple manner other branches of the subject upon which erroneous views still existed. Most of the more valuable treatises, such as those by Professor Abbé and the late Dr. Fripp, were in a rather technical and abstruse form. This partly accounted for the reluctance shown by some of our best workers to adopt the most important theories of microscopical vision; preferring to draw their own conclusions from what they saw.

Mr. E. M. Nelson said he had listened to the paper with great pleasure, and he believed they would nowhere find a more clear and concise description of interference phenomena than had been given to them by the President that evening. He hoped Mr. Ingpen's words would come true as to its leading to the production of a treatise on the subject in some simple form; indeed, he thought they were a lucky Society to get such a paper as they had just heard. It had dealt with the subject so fully that he felt he could add nothing to it; every point seemed to have been touched. As, however, his name had been mentioned, he might say that he was very glad that he had been the means of bringing it forward. Several members had talked to him about the subject of diffraction phenomena, and for that reason he thought he would bring a very simple description of them before the Club, and without pretending to produce anything like a full or perfect treatise upon the point, he took up the subject of diffraction with regard to diatom structure. If he had accepted the advice given by the Royal Microscopical Society he should have given up the study altogether, but he had not done so, and as a consequence he had derived a great deal of pleasure and profit from the study, finding that, though they could not, perhaps, pick up all the diffraction spectra, they could at any rate do a good deal. When looking at a specimen such as those he had frequently shown in that room, where the structure was shown to be irregular and not uniform, it was impossible to believe that the appearance seen was due to diffraction phenomena, which always tended to produce pictures with a regular pattern.

Mr. T. F. Smith said he could only express the delight which he felt on hearing this paper, which he thought would remove a great many discouragements from the way of those who generally got pushed aside as recording nothing but diffraction defects. He thought that to believe in a theory was one thing, but to believe in the application of it was another,

and so, while he might say he believed in the theory, he would also say that he did not believe in its application. Professor Abbé said, with regard to *Amphipleura pellucida*, that you could not tell anything at all about the structure, consequently one was always being met by "what Professor Abbé says about it." In the Royal Microscopical Society's Journal they were shown a number of effects which took place in the case of *Pleurosigma angulatum*, but with regard to these he could only say that what was true was not new, and what was new was not true; in fact, the only one that was true was the figure shown by Mr. Wenham, and he was sure that when they looked at one side of the valve they got the same structure throughout, but on the other side they got effects which were due to a grating, which was in fact simply adding another structure.

The President, with regard to the remarks of Mr. Nelson, said that he was quite clear on the point that they could not have diffraction images irregularly, and that if irregular forms of structure were seen in such things as spiculæ, and sections or fractures of diatoms or other things, those appearances could not be due to diffraction. With regard to belief or disbelief in diffraction theories, he did not know how that could affect results; the important thing was rather a question of belief or disbelief in the instrument they worked with. They could not, of course, see anything that the instrument did not show, but the point was whether, under certain conditions, they could from what they saw determine the nature of the structure.

The Chairman said that after the way in which the paper had been received it was hardly necessary for him to ask them for a vote of thanks to the President for what had certainly been one of the clearest and most practical demonstrations on the subject to which he had yet listened, and it would form a most important addition to the information which had been written on the subject. The day had not yet come when the microscope could be pronounced perfect, and in view of this an explanation such as they had listened to that evening could not fail to be of the highest importance, and had evidently been received by the members with extreme appreciation.

A vote of thanks to the President was unanimously carried.

Announcements of meetings, etc., for the ensuing month were then made and the proceedings terminated with the usual Conversazione, the following objects being exhibited:—

Choano flagellata, etc.	Mr. F. W. Andrew.
Section of earthworm, *Lumbricus rubellus* ...	Mr. H. E. Freeman.
Leaf of *Plumbago capensis alba*...	Mr. G. E. Mainland.

Attendance—Members, 45; Visitors, 2.

February 8th, 1889.—Conversational Meeting.

The following objects were exhibited:—

Larva of *Corethra plumicornis*	Mr. F. W. Andrew.
Nostoc, sp.	Mr. G. E. Mainland.
Biddulphia reticulata	Mr. H. Morland.
Mastax of *Hydatina senta*	Mr. J. Spencer.

February 22nd, 1889.—Twenty-third Annual Meeting.

B. T. Lowne, Esq., F.R.C.S., F.L.S., etc., President, in the Chair.

The minutes of the preceding meeting were read and confirmed.

Mr. Albert Ashe was balloted for and duly elected a member of the Club.

The following additions to the Library were announced:—

"Journal of the New York Microscopical Society"	In Exchange.
"Journal of the Royal Microscopical Society"...	"
"The Botanical Gazette"	"
"The American Monthly Microscopical Journal"	"
"Proceedings of the Royal Society"	"
"Proceedings of the Natural History Society of Northumberland"	"
"Annals of Natural History"	Purchased.
"Catalogue of Foraminifera	"
Photo-micrographic Catalogue, and a number of prints, for distribution, of *Pleurosigma angulatum*, × 4900	From Dr. Roderic Zeiss.

The thanks of the Club were voted to the donors, especially to Dr. Roderic Zeiss for his valuable contribution.

The Secretary announced that a Special Exhibition Meeting would be held on March 8th, also that the Annual Dinner was arranged to take place on March 16th.

The President having appointed Messrs. Stocks and Burton to act as scrutineers, the ballot for the election of Officers and Committee for the ensuing year was proceeded with.

The Secretary read the 23rd Annual Report of the Committee.

The Treasurer's annual report and balance-sheet was read, the same having been duly audited by Messrs. W. Hainworth and F. H. P. Hind.

On the motion of Mr. Morland, seconded by Mr. Burton, it was resolved "that these reports be received and adopted, and that they be printed and circulated in the usual way."

The President delivered his Annual Address, on this occasion taking up the subject of Insect Anatomy from a historical point of view.

Mr. E. T. Newton said he had the pleasant duty to perform of asking the members present to return their hearty thanks to the President for the address, to which he felt sure they must all have listened with the greatest interest, and in moving a resolution to that effect he would also couple with it a request that he would allow it to be printed in the Journal.

Mr. J. W. Reed having seconded the motion, it was put to the meeting by Mr. Newton and carried by acclamation.

The President expressed his thanks to the members for the manner in which they had received his address, and for the vote of thanks which they

had so heartily carried. He said he had also further to thank them for the honour they had conferred upon him by his re-election to the office of President of the Club, as he found by the report just handed in by the scrutineers.

The result of the ballot was then read, as follows :—

President—Prof. B. T. Lowne, F.R C.S., F.L.S., etc.

Vice-Presidents—A. D. Michael, F.L.S., F.R.M.S., etc.; Prof. C. Stewart, M.R.C.S., F.L.S., F.R.M.S., etc.; E. T. Newton, F.G.S., etc.; E. M. Nelson.

Hon. Treasurer—F. W. Gay, F.R.M.S.

Hon. Secretary—G. C. Karop, M.R.C.S., F.R.M.S., etc.

Hon. Secretary for Foreign Correspondence and Editor of Journal—Henry F. Hailes.

Hon. Reporter—R. T. Lewis, F.R.M.S.

Hon. Librarian—Alpheus Smith.

Hon. Curator—Chas. Emery.

Five members of Committee—J. Spencer, F.R.M.S., H. Morland, E. Dadswell, F.R.M.S., W. W. Reeves, F.R.M.S., C. Rousselet, F.R.M.S.

On the motion of Mr. Terry, a vote of thanks to the scrutineers and auditors for their services was unanimously carried.

A vote of thanks to the officers and Committee was moved by Mr. Willson and carried unanimously.

The Secretary said there was one other vote of thanks which they were asked to carry, and that was to the Council of University College for the privilege accorded to the Club of holding its meetings in that building free of any charge for rental whatever. As he had perhaps more to do with the College authorities than anyone else connected with the Club, he thought it would be proper that this proposition should be made by himself. He could only add that he had at all times found them to be most liberal and courteous in any dealings which he had with them, and he felt sure the members would give due expression to the indebtedness which they felt for the advantages received.

The motion was unanimously carried by acclamation.

Announcements of meetings for the ensuing month were then made, and the proceedings terminated with the usual Conversazione.

Attendance—Members, 43; Visitors, 3.

REPORT OF THE COMMITTEE.

February 22nd, 1889.

Your Committee, in presenting the Twenty-third Annual Report, are happy to state that the position of the Club is in every way satisfactory.

During the past year twenty-six new members were elected, eighteen have resigned, and death has removed six. One of these, Mr. Henry Lee, was a former President and well-known naturalist.

The number of members, therefore, is almost identical with last year's total.

The finances of the Club, as will be seen from the Treasurer's Report, show no falling off in the available balance at disposal.

Although nothing very novel has been produced, there has been no lack of useful contributions brought before the meetings.

The following is a list of the more important :—

1888.

Jan. 27. "On the Formation of Diatom Structure," by Mr. E. M. Nelson.

" "On the Beaded Villi of Butterfly and Moth Scales," by Dr. Royston Pigott, F.R.S.

Mar. 23. "On Marine Aquaria," by Mr. Waddington.

" "On Arachnoidiscus as a test for high powers," by Mr. T. F. Smith.

April 27. "On some Sponge Spicules in a deposit from Oamaru," by Mr. Priest.

May 25. "On the Reproductive Organs of some of the Florideæ," by Mr. Buffham.

" "On True and False Images in Microscopy," by Mr. T. F. Smith.

June 22. "On Encysted Diatoms," by Mr. Isaac Robinson.

Sept. 28. "On the Structure of the Pleurosigma Valve," by Mr. T. F. Smith.

Oct. 26. "On the Fungi found upon Theobroma Cacao," by Mr. H. Epps.

Nov. 23. "On Mounting Diatoms," by Mr. Morland.

" "On Perophora Listeri," by Mr. Rousselet.

Dec. 28. "On a New Rotifer, Limnias cornuella," by Mr. Rousselet.

" "On Coccidæ from British Guiana," by Mr. McIntire.

" "Remarks on Ortonia and Icerya (plant bugs)," by Mr. R. T. Lewis.

In consequence of the abolition of the Ordinary Meetings in July and August, as determined at the last Annual General Meeting, there has been some little reduction in the amount of printable matter, so that three journals only have been published during the year instead of four as hitherto. There will be no objection to issue the usual number in future provided the Editor is supplied with sufficient matter in the shape of papers, which, of course, rests with the members themselves.

The following is a list of the books added to the Library by gift or purchase :—

"A Fauna and Flora within Living Animals" (Leidy)	Mr. F. Crisp.
"Objects for the Microscope" (Clarke)	"
"The Microscope and its Revelations" (Ferguson)	"
"Handbook to the Microscope" (Notcutt)	"
"Transactions of the Linnean Society"	"
"Tentamen Hydrophytologial Danicæ" (Lyngbye)	"
"Beitrage zur Naturgeschicte der Daphnoiden" (Weismann)...	"
"Naturgeschicte der Infusionsthiere" (Kutorga) ...	"
"Die frei lebenden Copepodon" (Claus)	"
"Recherches sur les Phenomènes Sexuels des Infusoires" (Balbiana)	"
Dr. Braithwaite's "Moss Flora," Part 11	The Author.
"The Medical and Surgical History of the War of the Rebellion," Part 3	U.S. Government.
"Journal of the Royal Microscopical Society" ...	The Society.
"Proceedings of the Royal Society"	"
"Science Gossip"	The Publishers.
"American Naturalist"	In Exchange.

"American Monthly Microscopical Journal"...	...	In Exchange.
"Journal of Microscopy"	... ...	"
"Scientific Inquirer"	... ...	"
"Botanical Gazette"	... ...	"
"British Oribatidæ," Vol. ii.	... ...	By Subscription Ray Society.
Teall's "British Petrography" (completion)	...	Purchased.
"Quarterly Journal of Microscopical Science"	...	"
"Grevillea"	... ...	"
"Annals and Magazine of Natural History"	...	"
"Challenger Zoological Reports," Vols. xxii.-xxix....		

Proceedings of various Scientific Societies and Sundry Pamphlets.

On March 9th a Special Exhibition Meeting was held in the Library by kind permission of the College Authorities. This was well attended by members and their friends, numerous objects of interest were displayed, and altogether the evening was very successful.

With the concurrence of the Council, the next Special Exhibition Meeting will take place on March 8th. Notices have been sent to all members, and the Committee trust that individual effort will not be wanting to render it, if possible, better than the last.

The following slides have been presented to the Cabinet since the last Report:—

Mr. Smart	1
" T. F. Smith	24
" E. T. Browne...	10
" Hampton	12
" F. Kitton	4
" F. H. P. Hind...	3
" H. Morland	12
" R. T. Lewis	2
" S. J. McIntire	3
Dr. Gray	8
Total	79

The Excursions of the past year were very favourable, and the attendances fully up to the average. Among the finds were several rare Rotifers and a species of Collembola hitherto unfigured. The day's excursion to Whitstable was enjoyed as usual by those attending it, and Mr. Saunders lent his kind aid in organizing the dredging party, which forms the chief attraction on this occasion.

From unavoidable causes the date of the Annual Dinner has been postponed until March 16th. Care will in future be taken to keep to the proper day, viz., the Saturday following the Annual Meeting if possible, but from the long notice which has to be given a delay is not always to be prevented.

For some time past it has been found by the College Librarian that serious damage is being done to the books in his charge by the gas, which is principally consumed by the Societies holding meetings here with the sanction of the Council. They have, therefore, reluctantly been obliged to withdraw their permission for this and other similar bodies to continue the use of the Library for their meetings. With their accustomed courtesy and liberality, however, they have placed the Mathematical Theatre at our disposal, and have endeavoured to meet our requirements in every possible way.

In accepting this offer your Committee desire to express their most sincere thanks to the Council for their kindness, well knowing as they do that this step was absolutely necessary in order to preserve the College property.

Your Committee likewise wish to thank the officers of the Club individually for their services, as much of its success is due to their efforts.

Your Committee feel sure that the position the Club has attained and kept for so many years will continue, based as it is on the goodwill and fellowship existing among its members, who all desire to further its progress by communicating the results of their labours for the general good of others following the same pursuit.

INDEX.

OFFICERS AND COMMITTEE.

(Elected February, 1887.)

President.

A. D. Michael, F.L.S., F.R.M.S.

Vice-Presidents.

Prof. C. Stewart, M.R.C.S., F.L.S., &c.
E. T. Newton, F.G.S., &c.
E. M. Nelson.
J. W. Groves, F.R.M.S.

Committee.

T. C. White, M.R.C.S., L.D.S.
B. W. Priest.
J. G. Waller.
F. W. Hembry, F.R.M.S.
W. W. Reeves, F.R.M.S.
E. Dadswell.
A. W. Stokes, F.C.S.
H. Morland.
G. Sturt, F.R.M.S.
F. A. Parsons, F.R.M.S.
J. J. Vezey, F.R.M.S.
H. J. Waddington.

Hon. Treasurer.

F. W. Gay, F.R.M.S., 113, High Holborn, W.C.

Hon. Secretary.

G. C. Karop, M.R.C.S., 198, Holland Road, Kensington, W.

Hon. Sec. for Foreign Correspondence and Editor of Journal.

Henry F. Hailes, 15, Westfield Road, Hornsey, N.

Hon. Reporter.

R. T. Lewis, F.R.M.S.

Hon. Librarian.

Alpheus Smith,
8, Hanover Park, Peckham, S.E.

Hon. Curator.

Charles Emery,
9, New Road, Crouch End, N.

PAST PRESIDENTS.

		Elected.
EDWIN LANKESTER, M.D., F.R.S. - -	July,	1865.
ERNEST HART - - - - - -	,,	1866.
ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.	,,	1867.
,, ,, ,, ,, - -	,,	1868.
PETER LE NEVE FOSTER, M.A. - -	,,	1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	,,	1870.
,, ,, ,, ,, - -	,,	1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	,,	1872.
,, ,, ,, ,, - -	,,	1873.
JOHN MATTHEWS, M.D., F.R.M.S. - -	,,	1874.
,, ,, ,, ,, - -	,,	1875.
HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	,,	1876.
,, ,, ,, ,, - -	,,	1877.
THOS. H. HUXLEY, LL.D., F.R.S., &c. - -	,,	1878.
T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., &c.		1879.
T. CHARTERS WHITE, M.R.C.S., F.L.S., &c.	,,	1880.
,, ,, ,, ,, - -	,,	1881.
M. C. COOKE, M.A., LL.D., A.L.S. ,, - -	,,	1882.
,, ,, ,, ,, - -	,,	1883.
W. B. CARPENTER, C.B., F.R.S., &c., &c. -	,,	1884.
A. D. MICHAEL, F.L.S., F.R.M.S., &c. - -	,,	1885.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 120, Belleville avenue, Newark, New Jersey, U.S.A.
Mar. 19, 1869.	The Rev. E. C. Bolles, Salem, Mass., U.S.A.
July 26, 1872.	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872.	Prof. Hamilton L. Smith, President of Hobart College, Geneva, New York, U.S.A.
July 23, 1875.	Lionel S. Beale, M.B., F.R.S., F.R.M.S., &c. (*Past President*), 61, Grosvenor street, W.
Sept. 22, 1876.	Frederick Kitton, Hon. F.R.M.S., &c., 8, West Kensington terrace, W.
July 25, 1879.	Dr. E. Abbe, University, Jena, Saxe Weimar, Germany.
July 23, 1880.	F. H. Wenham, C.E., 112, New Bond street, W.
Nov. 24, 1882.	Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869.	Ackland, William, L.S.A., F.R.M.S., 416, Strand, W.C.
Oct. 26, 1883.	Addiscott, C. J., Sydney Villa, St. Bildas road, Manor park, Stoke Newington, N.
Nov. 27, 1868.	Adkins, William, 431, Oxford street, W.
Mar. 23, 1866.	Allbon, William, F.R.M.S., 37, Gloucester place, Portman square, W.
Oct. 24, 1884.	Allen, W. A., 156, Choumert road, Rye lane, Peckham, S.E.
July 26, 1872.	Alstone, John, 68, Shepherd's Bush road, W.
Dec. 17, 1869.	Ames, G. A., F.R.M.S., Union Club, Trafalgar square, W.C.
Dec. 22, 1865.	Andrew, F. W., 3, Neville terrace, Onslow gardens, S.W.
May 28, 1875.	Arrowsmith, Wastell, 99, Adelaide road, Haverstock hill, N.W.
June 22, 1883.	Ash, George C., 141, Maida vale, W.
July 25, 1879.	Ashbridge, Arthur, 76, Leadenhall street, E.C.
Sept. 27, 1878.	Ashby, H. T., 8, Bartholomew road, Kentish Town, N.W.
June 26, 1874.	Badcock, John, F.R.M.S., 270, Victoria park road, South Hackney, E.
Dec. 28, 1883.	Bailey, Rev. G., The Manse, Finchingfield, Essex.
Dec. 27, 1867.	Bailey, J. W., 75, Broke road, Dalston, E.
April 24, 1868.	Baker, Charles, F.R.M.S., 244, High Holborn, W.C.
Feb. 25, 1876.	Ballard, Dr. W. R., jun., 26, Manchester square, W.

Date of Election.	
Jan. 24, 1879.	Barham, G. T., Danehurst, Hampstead, N.W.
Dec. 27, 1872.	Barnard, Herbert, 33, Portland place, W.
April 22, 1870.	Barnes, C. B., 4, Egremont villas, White horse lane, South Norwood, S.E., and 27, Clement's lane, E.C.
July 27, 1883.	Barnes, Henry, Patschull house, Dartmouth Park avenue, N.
May 25, 1883.	Barratt, Thomas, Bell Moor House, Upper Heath, Hampstead, N.W.
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught square, W.
Dec. 28, 1877.	Batchelor, J. A., 8, Bow lane, E.C.
June 27, 1883.	Bates, E., Assoc.I.C.E., 45, Fentiman's road, Clapham road, S.E.
Nov. 26, 1875.	Beaulah. John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., 31, Cornhill, E.C.
May 26, 1871.	Bedwell, Judge, M.A. Cantab, F.R.M.S., West parade, Hull, Yorkshire.
Mar. 28, 1884.	Beetham, A., 14, South square, Gray's Inn, W.C.
June 25, 1886.	Bernau, F. G., "Brabant," Tulse hill, S.W.
May 22, 1868.	Berney, John, F.R.M.S., 61, North end, Croydon.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., "Avondale," Coloraine road, Blackheath, S.E.
July 23, 1886.	Bickerton, G. A., St. George's Lodge, Queen's road, Richmond, Surrey.
Mar. 28, 1879.	Bird, F. E., 33, St. Saviour's road, Brixton hill, S.W.
Feb. 23, 1866.	Blake, T., Fernside, Kent road, East Molesey, Surrey.
July 27, 1877.	Blenkinsop, B., Shord hill, Kenley, Surrey.
May 26, 1876.	Blundell, J., Stock Exchange, E.C.
Dec. 27, 1881.	Bolton, J. G. E., M.R.C.S., Savanne, Mauritius.
Jan. 22, 1875.	Bolton, Thomas, F.R.M.S., 57, Newhall street, Birmingham.
Nov. 23, 1883.	Bostock, E., "The Radfords," Stone, Staffordshire.
Jan. 23, 1885.	Bousfield, E. C., L.R.C.P.Lond., M.R.C.S., 363, Old Kent road, S.E.

Date of Election.	
Oct. 27, 1865.	Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*Past President*), The Ferns, 303, Clapham road, S.W.
May 26, 1876.	Brigstock, J. W., "Ferntower," Manor road, Stoke Newington, N.
Mar. 25, 1887.	Broad, C. S., The Chestnuts, Harlesden, N.W.
Oct. 27, 1883.	Brown, Fredk. Wm., 35, Walterton road, St. Peter's park, Harrow road, W.
Sept. 26, 1879.	Brown, William, B.Sc., 3, Elm cottages, Middle lane, Crouch end, N.
May 22, 1868.	Brown, W. J., 4, 17, Maple road, Anerley, S.E.
Jan. 28, 1887.	Browne, E. T., Uxbridge Lodge, Uxbridge road, Shepherd's Bush, W.
May 26, 1871.	Browne, George, 45, Victoria road, Kentish town, N.W.
May 28, 1875.	Browne, J. W., Frascati, Masons hill, Bromley, Kent.
Feb. 27, 1872.	Browne, Rev. T. H., F.R.M.S., F.G.S., M.E.S., High Wycombe, Bucks.
Jan. 23, 1880.	Browne, W. R., Alder cottage, Isleworth.
June 25, 1886.	Bryant, E., "The Corellis," Anson road, Tufnell park, N.
May 22, 1885.	Buckland, H., Ivy Holt, Station road, Sidcup, Kent.
Dec. 22, 1882.	Bucknall, Edward, 16, Junction road, Highgate, N.
Jan. 26, 1877.	Buffham, T. H., Hughenden villa, Comley Bank road, Walthamstow.
June 22, 1883.	Burbidge, William Henry, Stanley House, Alleyn park, Dulwich, S.E.
Aug. 22, 1879.	Burton, William, 27, Wigmore street, W.
Feb. 26, 1886.	Butcher, W. J., B.Sc., Emanuel College, Wandsworth Common, S.W.
June 14, 1865.	Bywater, W.M., F.R.M.S., 5, Hanover square, W.
June 25, 1880.	Cambridge, John, Bury St. Edmunds, Suffolk.
May 23, 1879.	Carpenter, H. S., F.R.M.S., Beckington house, Weighton road, Anerley, S.E.
July 23, 1880.	Carr, Ebenezer, 26, Bromar road, Denmark park, S.E.

Date of Election.	
May 26, 1882.	Chapman, W. Ingram, 5, Hollywood villas, Melrose road, Southfields, S.W.
Dec. 27, 1878.	Chatto, Andrew, 214, Piccadilly, W.
Nov. 27, 1874.	Chippindale, George, Grape villa, Rothschild road, Chiswick High road, W.
Dec. 27, 1881.	Claremont, Claude Clarke, M.R.C.S., Millbrooke house, Hampstead road, N.W.
Feb. 23, 1883.	Clark, Joseph, F.R.M.S., Hind Hayes, Street, Somerset.
Oct. 23, 1885.	Clayton, C., Cottesloe, Chatsworth road, Croydon.
May 22, 1885.	Clinch, J. W., Lake Brewery, Douglas, Isle of Man.
May 22, 1868.	Cocks, W. G., 36, Gayhurst road, Dalston, E.
Sept. 22, 1876.	Cole, A. C., F.R.M.S., 171, Ladbrooke Grove road, Notting hill, W.
Nov. 23, 1883.	Cole, Martin, 1, Maze villas, Priory Park, Kew.
Jan. 25, 1867.	Coles, Ferdinand, F.L.S., 53, Brooke road, Stoke Newington common, N.
Oct. 23, 1885.	Collins, C., Rathmines, St. Mary's road, Harlesden, N.W.
Mar. 24, 1876.	Colsell, G. D., 1, Dermody road, East Down, Lewisham, S.E.
June 14, 1865.	COOKE, M.C., M.A., LL.D., A.L.S. (*Past President*), 146, Junction road, Upper Holloway, N.
Feb. 22, 1867.	Cooper, F. W., L.R.C.S.Edin., Leytonstone, E.
June 27, 1873.	Corbett, A. L., 11, Orlando road, Clapham, S.W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., H.M.Office of Woods, Whitehall place, S.W.
Jan. 22, 1886.	Coventon, C. A., Morwenstow, West Enfield.
July 26, 1872.	Cowan, T. W., F.G.S., F.R.M.S., Avenue de la Gare, Lausanne, Switzerland.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., *V.P. and Treas. Linnean Society; Hon. Sec. Royal Microscopical Society*, 5, Lansdowne road, Notting hill, W.
Dec. 23, 1870.	Crisp, J. S., F.R.M.S., Ashville, Lewin road, Streatham, S.W.
July 26, 1878.	Crockford, Wm., 2, St. Peter's road, Mile end, E.
Feb. 23, 1877.	Crofton, Edward, M.A.Oxon., F.R.M.S., 45, West Cromwell road, South Kensington, S.W.

Date of Election.	
June 25, 1886.	Crookshank, E. M., M.B., 24, Manchester square, W.
Sept. 26, 1884.	Crowhurst, H. A., 313, High Holborn, W.C.
June 25, 1880.	Curties, C. Lees, 244, High Holborn, W.C.
May 25, 1866.	Curties, Thomas, F.R.M.S., 244, High Holborn, W.C.
June 25, 1880.	Curties, W. Irvin, 244, High Holborn, W.C.
Sept. 26, 1879.	Curtis, Charles, 29, Baker street, Portman sq., W.
April 22, 1881.	Cutting, W. M., 1, Curtain road, E.C.
Aug. 27, 1886.	Daddo, W. S., M.A., 59, Southborough road, South Hackney, E.
Jan. 22, 1875.	Dadswell, Edward, 42, Barrington road, Stockwell, S.W.
Nov. 23, 1877.	Dallas, W. S., F.L.S., &c., the Geological Society, Burlington house, Piccadilly, W.
Feb. 23, 1883.	Dallinger, Rev. W. H., F.R.S., F.R.M.S., (*President R.M.S.*), Wesley College, Sheffield.
May 23, 1879.	Dallmeyer, T. R., 19, Bloomsbury street, W.C.
Mar. 22, 1878.	Darke, Edward, 16, Rochester terrace, Camden road, N.W.
Aug. 23, 1883.	Davis, H., 108, Sandringham road, Dalston, E.
May 23, 1879.	Dawson, W., F.R.M.S., 24, Abbeygate street, Bury St. Edmunds, Suffolk.
May 28, 1875.	Dean, Arthur (*Hon. Sec. East Lond. Mic. Soc.*), 57, Southborough road, South Hackney, E.
Mar. 22, 1878.	Dean of Chester, The, The Deanery, Chester.
Feb. 28, 1879.	Debenham, E. H., 9, Mincing lane, E.C.
Jan. 24, 1879.	Deby, Julien, C.E., F.R.M.S., 31, Belsize Avenue, St. John's Wood, N.W.
Nov. 24, 1876.	Despointes, Francis, 16, St. George's square, Regent's park road, N.W.
Nov. 27, 1868.	Douglas, Rev. R. C., Manaton Rectory, Moreton-hampstead, Exeter.
Oct. 25, 1878.	Dowler, Captain F. E., 28, Albermarle street, W.
May 25, 1883.	Drake, C. A., The Distillery, Three Mill lane, Bromley-by-Bow.
July 25, 1879.	Driver, Alfred, 30, Leigham court road west, Streatham, S.W.

Date of Election.

Oct. 25, 1872. Dunning, C. G., 55, Camden park road, N.W.

Sept. 22, 1865. DURHAM, A. E., F.R.C.S., F.L.S., F.R.M.S., &c. (*Past President*), 82, Brook street, Grosvenor square, W.

July 27, 1883. Durrand, Alexander, 5, Philbrick terrace, Nunhead lane, Peckham Rye, S.E.

Sept. 25, 1868. Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.

June 28, 1867. Edmonds, R., Royal Arsenal, Woolwich, S.E.

July 25, 1884. Ellis, J. H., The Lindens, Geraldine road, Wandsworth, S.W.

May 26, 1876. Emery, Charles (*Hon. Curator*), 9, New road, Crouch end, N.

May 26, 1881. Enock, Frederick, 11, Parolles road, Upper Holloway, N.

Feb. 28, 1879. Epps, Hahnemann, 95, Upper Tulse hill, Brixton, S.W.

Feb. 21, 1884. Epps, J., jun., "The Homestead," Ross road, South Norwood hill, S.E.

Dec. 27, 1878. Erlebach, H. A., Forest House School, Woodford.

July 25, 1873. Fase, Rev. H. J., 8, Dents road, Wandsworth common, S.W.

June 25, 1875. Faulkner, Henry, jun., Fernwood, Roehampton park, S.W.

Jan. 28, 1876. Faulkner, John, 20, Mornington crescent, N.W.

Aug. 25, 1882. Field, W. H., 39, Crouch Hall road, Crouch end, N.

Feb. 27, 1880. Fieldwick, Alfred, jun., 284, Dalston lane, Hackney, E.

July 22, 1881. Firth, W. A., Whiterock, Belfast.

July 26, 1867. Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh house, Highbury New park, N.

Feb. 24, 1882. Fitch, J. N., 17, Eversholt street, Camden Town, N.W.

Oct. 26, 1883. Fleetwood, G., 388, Camden road, N.

Nov. 28, 1879. Forster, William, jun., Cleveland road, Woodford, Essex.

Date of Election.	
Mar. 24, 1871.	Foulerton, John, M.D., 44, Pembridge villas, Bayswater, W.
Oct. 24, 1884.	Fowler, C., Estelle road, Mansfield road, Gospel Oak, N.W.
Dec. 28, 1866.	Fox, C. J., F.R.M.S., 65, Faubourg Poissonnière, Paris.
Nov. 26, 1875.	Freckelton, Rev. T. W., F.R.M.S., 28A, Lonsdale square, Islington, N.
June 23, 1871.	Freeman, H. E., 104, Shaftesbury road, Crouch hill, N.
May 22, 1868.	Fryer, G. H., 107, Belsize road, N.W.
July 23, 1880.	Funston, James, 93, Finsbury pavement, E.C.
Mar. 25, 1870.	Garden, R. S., 42, Carlton hill, St. John's wood, N.W.
Jan. 23, 1885.	Garner, J. B., 75, Sparkenhoe street, Leicester.
April 23, 1880.	Gates, G. W. H., 21, Lombard street, E.C.
July 7, 1865.	Gay, F. W., F.R.M.S. *(Hon. Treasurer)*, 113, High Holborn, W.C.
June 25, 1880.	George, C. F., M.R.C.S., Kirton-in-Lindsey, Lincolnshire.
July 26, 1867.	George, Edward, F.R.M.S., Vernon House, Westward Park, Forest hill, S.E.
April 27, 1877.	Gilberston, Henry, Mangrove house, Hertford.
Oct. 27, 1876.	Gilburt, W. H., F.R.M.S., 48, Wetherell road, South Hackney, E.
Nov. 28, 1879.	Goodinge, A. C., 119, High Holborn, W.C.
April 26, 1872.	Goodinge, J. W., F.R.G.S., F.R.M.S., 119, High Holborn, W.C.
Nov. 23, 1877.	Goodwin, William, 10, Prospero road, Upper Holloway, N.
July 27, 1883.	Goold, Ernest H., C.E., F.Z.S., M.R.I., 4, Dane's Inn, Strand, W.C.
Mar. 27, 1866.	Gray, S. O., Bank of England, E.C.
Aug. 24, 1885.	Greenhough, D. W., 210, Lewisham road, St. John's, S.E.
Feb. 24, 1882.	Greening, Linnæus, Birch house, Warrington.
Oct. 23, 1868.	Greenish, Thomas, F.R.M.S., 20, New street, Dorset square, N.W.
Oct. 23, 1868.	Gregory, H. R., 7, Quality court, Chancery lane.

Date of Election.	
Feb. 25, 1887.	Gross, W., 23, York place, Portman square, W.
Jan. 28, 1887.	Grove, E., 20, Cumberland road, Kew.
July 24, 1868.	Groves, J. W., F.R.M.S., 90, Holland road, Kensington, W.
July 24, 1868.	Grubbe, E. W., C.E., 90, Portland road, South Kensington, W.
Jan. 27, 1871.	Guimaraens, A. de Souza, F.R.M.S., 52, Lowden road, Herne hill, S.E.
Sept. 28, 1877.	Hagger, John, Repton school, Burton-on-Trent.
Feb. 25, 1881.	Haigh, William, Tempsford villa, Uxbridge road, Ealing, W.
June 14, 1865.	Hailes, H. F. (*Hon. Secretary for Foreign Correspondence and Editor*), 15, Westfield road, Hornsey, N.
Aug. 26, 1870.	Hailstone, R. H., 91, Adelaide road, N.W.
Feb. 23, 1867.	Hainworth, William, 105, Darenth road, Stamford hill, N.
Dec. 28, 1866.	Hallett, R. J., 123, Seymour street, Euston square, N.W.
Feb. 22, 1869.	Hammond, A., F.L.S., 5, Swiss terrace, Elmers end road, Beckenham, S.E.
Oct. 22, 1886.	Hampton, W., 38, Lichfield street, Hanley, Staffordshire.
June 25, 1880.	Hancock, H. S. H., 50, Springdale road, Stoke Newington, N.
Feb. 24, 1882.	Harding, J. H., 4, Finsbury square, E.C.
July 25, 1879.	Hardingham, G. G., F.R.M.S., 33, St. George's square, S.W.
Jan. 23, 1874.	Hardy, J. D., F.R.M.S., 73, Clarence road, Clapton, E., and 4, Lombard street, E.C.
Sept. 28, 1866.	Harkness, W., F.R.M.S., Laboratory, Somerset house, W.C.
Nov. 27, 1885.	Harris, F. W., Hilltop villa, Shootup hill road, Cricklewood, N.W.
April 23, 1875.	Harrison, James, 150, Akerman road, North Brixton, S.W.
May 23, 1884.	Havers, J. C., Wood Lea, Bedford hill, Balham, S.W.

Date of Election.	
Mar. 28, 1879.	Hawkins, C. E., H.M. Geological Survey, Jermyn street, S.W.
June 28, 1867.	Hawksley, T. P., 97, Adelaide road, N.W.
June 22, 1883.	Hazlewood, Jas. Edmund, F.R.M.S., 3, Lennox place, Brighton.
Aug. 23, 1872.	Hembry, F. W., F.R.M.S., Sussex Lodge, Sidcup, Kent.
June 26, 1868.	Henry, A. H., 73, Redcliffe gardens, S.W.
Feb. 26, 1886.	Hewlett, R. T., Sandhill house, King's farm, Richmond, Surrey.
April 25, 1884.	Higgins, J., London University, Burlington gardens, W.
June 22, 1877.	Hill, R. W., 41, Lothbury, E.C.
Feb. 25, 1887.	Hillier, J. T., 4, Chapel place, Ramsgate.
Sept. 24, 1869.	Hilton, T. D., M.D., Upper Deal, Kent.
Sept. 28, 1866.	Hind, F. H. P., 11, Copthall court, Throgmorton street, E.C.
May 22, 1874.	Hind, George, 244, High Holborn, W.C.
Feb. 26, 1875.	Holford, Christopher, Bounty Office, Dean's yard, Westminster, S.W.
Jan. 23, 1880.	Holland, C. F., 184, Brooke road, Upper Clapton, E.
April 26, 1867.	Hooton, Charles, Sunningdale house, Bickerton road, Upper Holloway, N.
Nov. 26, 1880.	Hopkins, Robert, Shern villa, Walthamstow, Essex.
Oct. 26, 1866.	Horncastle, Henry, Cobham, near Woking station.
May 22, 1874.	Hovenden, C. W., F.R.M.S., 95, City road, E.C.
April, 26, 1867.	Hovenden, Frederick, F.R.M.S., Glenlea, Thurlow park road, Dulwich, S.E.
Oct. 27, 1876.	Howard, D., 60, Belsize park, N.W.
Oct. 25, 1878.	Howling, W. E., Crowley's Brewery, Alton, Hants.
May 28, 1886.	Hughes, W., 32, Heathland road, Stoke Newington, N.
Jan. 23, 1880.	Hunt, Frederick, York lodge, Stamford hill, N.
Dec. 22, 1876.	Hunter, J. J., 20, Cranbourne street, W.C.
July 25, 1873.	Hurst, J. T., 1, Raymond villas, Geraldine road, Wandsworth, S.W.

Date of Election.

June 28, 1878. HUXLEY, PROF. T. H., F.R.S., &c. (*Past President*), Science Schools, South Kensington, S.W.

May 24, 1867. Ingpen, J. E., F.R.M.S., 7, The Hill, Putney, S.W.

Dec. 17, 1875. Jackson, C. L., F.L.S., F.Z.S., F.R.M.S., Hill Fold, Sharples, Bolton.

July 24, 1868. Jackson, F. R., Culver cottage, Slindon, Arundel, Sussex.

June 25, 1880. Jacques, Walter, 2, Fenchurch buildings, E.C.

Aug. 25, 1882. Jakeman, Christopher, 72, South street, Greenwich.

Feb. 27, 1885. Jaques, E. K., 36, Old Gravel lane, St. George's, E.

June 14, 1865. Jaques, Edward, B.A., H.M. Office of Woods, Whitehall place, S.W.

Feb. 21, 1884. Jennings, A. V., 8, Broadhurst gardens, South Hampstead, N.W.

July 24, 1868. Jennings, Rev. Nathaniel, M.A., F.R.A.S., 8, Broadhurst gardens, South Hampstead, N.W.

Feb. 24, 1871. Johnson, M. Hawkins, F.R.M.S., F.G.S., 379, Euston road, N.W.

Mar. 24, 1871. Johnstone, James, Leamington House, Malvern, Wilts.

Feb. 28, 1873. Jones, G. J., Duke street, Settle, Yorks.

May 23, 1873. Karop, G. C., M.R.C.S., &c. (*Hon. Secretary*), 198, Holland road, Kensington, W.

July 25, 1884. Kern, J. J., Fern Glen, Selhurst park, South Norwood, S.E.

Mar. 19, 1869. Kilsby, T. W., 4, Brompton villas, Edmonton.

April 22, 1881. King, H. W., The Cedars, Upper Park road, New Southgate, N.

Feb. 28, 1873. Kitsell, F. J., 24, St. Stephen's avenue, Goldhawk road, Shepherd's Bush, W.

Mar. 23, 1877. Kluht, H. J., 44, Norfolk terrace, Bayswater, W.

Feb. 25, 1887. Knott, W. F. B., 156, Camden road, N.W.

Jan. 24, 1879. Lancaster, A. H., 5, Campden hill gardens, Kensington, W.

Date of Election.	
Mar. 22, 1867.	Lancaster, Thomas, Bownham house, Stroud, Gloucestershire.
May 28, 1875.	Larkin, John, 24, Charterhouse square, E.C.
Nov. 26, 1880.	Larkin, R. J., 207, Piccadilly, W.
June 25, 1869.	Layton, C. E., 12, Upper Hornsey rise, N.
April 25, 1884.	Lawrence, T. W. P., 47, Upper Bedford place, W.C.
Aug. 28, 1868.	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), Old Change, E.C.
Mar. 19, 1869.	Lee, Henry, F.L.S., F.R.M.S., &c. (*Past President*), Renton House, 343, Brixton road, S.W.
July 25, 1876.	Le Pelley, C., 84, St. Thomas' road, Seven Sisters road, N.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 28, Mount Park crescent, Ealing, W.
Jan. 28, 1887.	Lightwood, A. S., 45, Roderick road, Mansfield road, N.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs platz, Frankfort-on-Maine.
Nov. 27, 1885.	Lloyd, F. G., Westleigh, Watford, Herts.
May 26, 1871.	Locke, John, 16, Georgiana street, Camden town, N.W.
April 23, 1869.	Long, Henry, 90, High street, Croydon.
Nov. 24, 1866.	Lovibond, J. W., F.R.M.S., St. Anne street, Salisbury.
Sept. 22, 1866.	Lovick, T., 53, Queen's crescent, Haverstock hill, N.W.
Jan. 22, 1886.	Lyons, A. W., 25, Bessborough gardens, S.W.
Nov. 23, 1866.	McIntire, S. J., F.R.M.S., 14, Hetley road, Uxbridge road, Shepherd's Bush, W.
Jan. 23, 1880.	Mackenzie, James, Warden villa, Uxbridge road, Ealing, W.
April 27, 1883.	McManis, Thos. John, 95, Almack road, Clapton, E.
Jan. 24, 1884.	Macrae, A. C., M.D., 119, Westbourne terrace, Hyde Park, W.
June 28, 1878.	Magor, J. B., L.D.S., 24, Chapel street, Penzance.

Date of Election.	
May 25, 1883.	Mainland, G. E., Glenthorp, Woodside lane, North Finchley, N.
May 25, 1883.	Mais, H. T. Coathorpe, M.I.C.E., Engineer in Chief, Adelaide, South Australia (care of T. Curties, 244, High Holborn, W.C.)
Sept. 27, 1872.	Manning, H. E. the Cardinal Archbishop, Archbishop's house, Westminster, S.W.
July 27, 1883.	Mansfield, Edward Joseph, *Graphic* Office, 190, Strand, W.C.
Jan. 23, 1880.	Martin, Francis, R.N., Shrub cottage, Fairfield road, Old Charlton, Kent.
April 26, 1867.	Matthews, G. K., St. John's lodge, Beckenham, Kent.
May 26, 1871.	May, J. W., F.R.M.S., Arundel House, Percy-cross, Fulham, S.W.
Feb. 25, 1876.	May, W. R., 109, Queen's road, Dalston, E.
Feb. 28, 1879.	Menzies, James, 149, Brecknock road, N.W.
May 22, 1874.	Messenger, G. A., Lloyds, E.C.
July 27, 1877.	MICHAEL, A. D., F.L.S., F.R.M.S. (*President*), Cadogan Mansions, Sloane square, Chelsea, S.W.
May 28, 1880.	Miles, Andrew, 19, Commercial road, Camberwell, S.E.
July 7, 1865.	Millett, F. W., F.R.M.S., Marazion, Cornwall.
Sept. 22, 1882.	Moore, George, 7, Draper's gardens, Throgmorton street, E.C.
July 26, 1878.	Morland, Henry, Cranford, near Hounslow.
Jan. 24, 1879.	Murray, James, Osborne house, 271, Goldhawk road, Shepherd's Bush, W.
Feb. 22, 1878.	Needham, S. H., F.R.G.S., F.G.S., 33, Somerfield road, Finsbury Park, N.
Mar. 24, 1876.	Nelson, E. M., Cleve house, West End lane, West Hampstead, N.W.
Mar. 24, 1871.	Nelson, James, 142, Brixton road, S.W.
Nov. 25, 1881.	Nevins, R. T. G., 80, Tufnell park road, N.
Jan. 26, 1872.	Newton, E. T., F.G.S., Geological Museum, Jermyn street, S.W.
Feb. 27, 1880.	Niven, George, Erkingholme, Coolhurst road, Crouch End, N.
May 22, 1874.	Nixon, P. C., Oporto, Portugal.

Date of Election.

Aug. 26, 1881. Northey, M. D., 4, Lower Brighton terrace, Surbiton.

Jan. 24, 1879. Offord, J. M., 6, Boundary road, St. John's Wood, N.W.
Dec. 22, 1876. Ogilvy, C. P., F.L.S., Sizewell house, Leiston, near Saxmundham, Suffolk.
May 24, 1878. O'Hara, Lt.-Col. Richard, F.R.M.S. (late Royal Artillery), West Lodge, Galway.
Dec. 28, 1883. Oliver, J., 123, Stamford street, S.E.
June 23, 1882. Ollard, John Alex., F.R.M.S., 38, Gracechurch street, E.C.
Dec. 27, 1867. Oxley, Frederick, F.R.M.S., 8, Crosby square, Bishopsgate street, E.C.

Feb. 25, 1887. Paine, F. G., The School House, Guilsborough, Northampton.
July 24, 1885. Parker, J. A.D., Sunny hill, Camden park, Chislehurst.
Mar. 27, 1885. Parritt, H. W., 103, Camden street, Camden town, N.W.
Oct. 27, 1871. Parsons, F. A., 90, Leadenhall street, E.C.
Feb. 25, 1887. Patterson, G., 7, Idol lane, Great Tower street, E.C.
July 23, 1886. Paul, R., Gloucester house, Hanwell.
April 23, 1875. Peal, C. N., F.R.M.S., Fernhurst, Mattock lane, Ealing, W.
Feb. 23, 1883. Pearce, Fredk. Ernest, 14, Bloomsbury street, W.C.
May 24, 1867. Pearson, John, 3, Westbourne Grove, W.
July 22, 1881. Perigal, Henry, F.R.A.S., F.R.M.S., 9, North crescent, Bedford square, W.C.
May 28, 1886. Peterborough, The Bishop of, The Palace, Peterborough.
Oct. 24, 1884. Petty, T., Deddington, Oxon.
Oct. 27, 1865. Pickard, J. F., 195, Great Portland street, W.
May 23, 1879. Pilcher, W. J., F.R.C.S., &c., Boston, Lincolnshire.
June 24, 1881. Pilley, J. J., Old College, Dulwich.
Jan. 22, 1869. Pillischer, Moritz, F.R.M.S., 88, New Bond street, W.

Date of Election.	
Sept. 27, 1878.	Plomer, G. D., F.R.M.S., 48, Springfield road, St. John's Wood, N.W.
Nov. 23, 1883.	Plowman, T., jun., Nystuen lodge, Bycullah park, Enfield.
Sept. 28, 1877.	Pocklington, Henry, F.R.M.S., 20, Park road, Leeds.
May 22, 1885.	Pocock, P. W., Remington villa, Egham, Surrey.
July 24, 1885.	Porter, J. L. M., 8, Wood vale, Forest hill, S.E.
Nov. 23, 1866.	Potter, George, F.R.M.S., 42, Grove road, Holloway, N.
Jan. 25, 1878.	Potts, R. A., 26, South Audley street, W.
June 24, 1881.	Potts, William, Winchester house, Old Broad street, E.C.
June 22, 1866.	Powe, I., 76, St. George's street, Richmond, Surrey.
Aug. 25, 1882.	Powell, George, 86, Avondale square, S.E.
April 25, 1879.	Powell, H. P., Mill Platt, Isleworth.
May 26, 1876.	Powell, J. T., 32, Dunlace road, Lower Clapton, E.
July 7, 1865.	Powell, Thomas, F.R.M.S., 18, Doughty street, Mecklenburg square, W.C.
June 27, 1873.	Priest, B. W., 22, Parliament street, S.W.
May 23, 1879.	Pritchard, J. D., Crymlyn Burrows, near Swansea.
July 26, 1867.	Pritchett, Francis, Clifford House, South Norwood Park, S.E.
Feb. 25, 1881.	Probyn, Clifford, 55, Grosvenor street, W.
April 23, 1868.	Quekett, A. J. S., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, A. E., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, Rev. Wm., The Rectory, Warrington.
Feb. 23, 1866.	Quick, G. E., 74, Long lane, Bermondsey, S.E.
Oct. 26, 1866.	Rabbits, W. T., Irongates, Dacres road, Forest hill, S.E.
June 25, 1875.	Radford, W. S., M.D., F.R.M.S., Sidmouth.
Oct. 26, 1866.	Ramsden, Hildebrand, M.A. Cant., F.L.S., F.R.M.S., 26, Upper Bedford place, Russell square, W.C.
Aug. 28, 1868.	Rance, T. G., Elmside, Bickley, Kent.
June 24, 1881.	Ransom, F., Fairfield, Hitchin.
Dec. 27, 1878.	Reed, J. M., Sidmouth house, South park, Ilford, E.

Date of Election.	
June 22, 1877.	Reed, J. W., F.R.G.S., F.R.M.S., 17, Colebrooke road, Islington, N.
June 27, 1873.	Reeve, Frederick, 113, Clapham road, S.W.
July 7, 1865.	Reeves, W. W., F.R.M.S., 32, Geneva road, Brixton, S.W.
Oct. 28, 1881.	Reynolds, W. P., 74, King William street, E.C.
June 25, 1886.	Richardson, S., 73, Normanton road, Derby.
Mar. 25, 1887.	Robinson, I., Hertford.
May 22, 1868.	Rogers, John, F.R.M.S., 4, Tennyson street, Nottingham.
Oct. 26, 1866.	Rogers, Thomas, F.L.S., F.R.M.S., Selmeston house, Thurlow park road, West Dulwich.
May 22, 1868.	Roper, Freeman, C.S., F.L.S., F.G.S., F.R.M.S., Palgrave house, Eastbourne, Sussex.
June 23, 1876.	Roper, H. J., F.R.M.S., 7, Carlton grove, Peckham, S.E.
Oct. 27, 1876.	Roper, Robert, Avisford, Blakehall road, Wanstead, E.
Jan. 24, 1884.	Rosseter, T. B., F.R.M.S., Fleur de Lis Hotel, Canterbury.
Jan. 26, 1883.	Rousselet, Charles, 308, Regent street, W.
July 24, 1868.	Rowe, James, jun., M.R.C.V.S., 65, High street, Marylebone, W.
April 24, 1885.	Russell, A. H., 10, Cleveland gardens, W.
Oct. 27, 1865.	Russell, James, 10, High street, Shoreditch, E.
May 22, 1868.	Russell, T. D., Coningsby villas, Rosendale road, West Dulwich, S.E.
Feb. 22, 1867.	Rutter, H. L., 24, Crownhurst road, Angel road, Brixton, S.W.
Nov. 22, 1878.	Sabel, E. E., 6, Grove road, Clapham park, S.W.
Dec. 17, 1869.	Salmon, John, 24, Seymour street, Euston square, N.W.
Dec. 28, 1877.	Sands, Charles, 5, Woburn place, Russell square, W.C.
Nov. 28, 1884.	Sanford, P. G., F.C.S., Blandford lodge, Streatham, S.W.
June 27, 1879.	Sawyer, G. D., F.R.M.S., 55, Buckingham place, Brighton.
Feb. 27, 1880.	Schulze, Adolf, 2, Doune gardens, Kelvinside, Glasgow, N.B.

Date of Election.

Mar. 24, 1882. Selby, H., 94, Wharton road, West Kensington park, W.

Mar. 26, 1886. Sercombe, H., 67, Lombard street, E.C.

July 27, 1868. Sewell, Richard, Ashmare house, Keston, Kent.

May 25, 1883. Sharer, W. R., 60, Thornhill square, Barnsbury, N.

July 23, 1880. Shaw, H. V., Fir Croft, Keymer, Hurstpierpoint, Sussex.

Oct. 22, 1869. Shaw, W. F., Mosshall Grove, Finchley, N.

May 26, 1876. Shepheard, Thomas, F.R.M.S., Kingsley lodge, Chester.

May 26, 1871. Sigsworth, J. C., F.R.M.S., 54, Portland road, Notting hill, W.

June 27, 1873. Simmonds, J. E., Royal Exotic Nursery, King's road, Chelsea, S.W.

Aug. 23, 1867. Simmons, J. J., L.D.S., 18, Burton crescent, Euston road, N.W.

Oct. 28, 1881. Simons, W. V., Nilgiri house, 5, Baldwyn crescent, Camberwell, S.E.

July 23, 1886. Simpson, D. G., 200, The Grove, Denmark hill, S.E.

May 26, 1876. Simpson, Edward, 24, Grummant road, Peckham road, S.E.

Feb. 23, 1883. Simpson, Isaac, 1, Junction road, Upper Holloway, N.

Nov. 23, 1877. Simpson, T., Fernymere, Castlebar, Ealing, W.

Dec. 28, 1866. Slade, J., F.G.S., Chappel road, Bexley heath, Kent.

Oct. 23, 1868. Smart, William, 27, Aldgate, E.

May 25, 1866. Smith, Alpheus (*Hon. Librarian*), 8, Hanover park, Peckham, S.E.

April 23, 1880. Smith, A. S., Silvermere, Cobham, Surrey.

Mar. 25, 1870. Smith, F. L., 3, Grecian cottages, Crown hill, Norwood, S.E.

June 27, 1873. Smith, G. J., F.R.M.S., 73, Farringdon street, E.C.

Oct. 26, 1877. Smith, Samuel, Maldon House, 17, Sydenham park, S.E.

Mar. 24, 1882. Smith, W. Dalton, 2, Craigs court, Charing Cross, S.W.

Aug. 23, 1872. Smith, W. S., 30, Loraine road, Holloway, N.

Aug. 22, 1884. Smithson, T. S., Facit, Rochdale.

Date of Election.	
July 24, 1885.	Snelgrove, A. G., Leighton villa, Upper Holloway, N.
Nov. 28, 1884.	Snell, F. A., The Chestnuts, Chislehurst.
April 24, 1868.	Snellgrove, W., 58, Cranfield road, Wickham park, S.E.
Sept. 22, 1865.	Southwell, C., Surrey lodge, Child's hill, N.W.
May 26, 1876.	Southwell, C. W., 227, Great Cheetham street, Higher Broughton, Manchester.
May 22, 1874.	Spencer, James, F.R.M.S., 121, Lewisham road, Lewisham.
Dec. 28, 1883.	Spetch, R. J., 1, Mitre court, Wood street, E.C.
Sept. 25, 1885.	Spriggs, A., Bank of England, E.C.
Mar. 27, 1885.	Squire, P. W., F.L.S., F.C.S., 40, Avenue road, Regent's Park, N.W.
Feb. 27, 1885.	Stephenson, J. W., F.R.A.S., F.R.M.S., 186, Clapham road, S.W.
Nov. 27, 1885.	Stevenson, G. T., Cunningham place, St. John's Wood, N.W.
Aug. 24, 1866.	Steward, J. H., F.R.M.S., 406, Strand, W.C.
June 22, 1877.	Stewart, Charles, M.R.C.S., F.L.S. *(Sec. R.M.S.)*, &c. *(Vice-President)*, Royal College Surgeons, Lincoln's Inn Felds, W.C.
May 23, 1879.	Stocken, James, 21, Endsleigh gardens, N.W.
June 24, 1881.	Stokes, A. W., F.C.S., Laboratory, Vestry hall, Paddington, W.
July 25, 1879.	Stone, E. M., Cumnor, Lawrie park, Sydenham, S.E.
May 23, 1879.	Stubbins, John, F.G.S., F.R.M.S., Inglebank, Far Headingley, Leeds.
Sept. 23, 1881.	Sturt, Gerald, 27, Gordon square, W.C.
July 7, 1865.	Suffolk, W. T., F.R.M.S., Petersfield, St. Julian's farm road, West Norwood, S.E.
June 24, 1870.	Swain, Ernest, 17, Tadmor street, Shepherd's Bush, W.
Nov. 22, 1867.	Swainston, J. T.
Nov. 24, 1866.	Swansborough, E., 20, John street, Bedford row, W.C.
Feb. 26, 1886.	Swanson, A. J., 112, Cheapside, E.C.
Dec. 17, 1875.	Swift, M. J., 81, Tottenham court road, W.C.
Jan. 23, 1880.	Symons, W. H., F.C.S., F.R.M.S., 130, Fellowes road, South Hampstead, N.W.

Date of Election.	
Feb. 25, 1887.	Tait, A. F., 77, Queen street, E.C.
July 27, 1877.	Tanqueray, A. C., Reid's Brewery, Theobald's road, E.C.
Nov. 28, 1879.	Tasker, J. G., 30, Junction road, Upper Holloway, N.
May 22, 1868.	Tatem, J. G., Russell street, Reading.
Feb. 25, 1881.	Taylor, Thomas, M.R.C.S., L.A.C., Bocking, near Braintree, Essex.
Aug. 23, 1878.	Teasdale, Washington, F.R.M.S., Rosehurst, Headingley, Leeds.
Dec. 22, 1865.	Terry, John, 8, Hopton park, Coventry park, Streatham, S.W.
Aug. 23, 1872.	Terry, Thomas, 5, Austin friars, E.C.
Mar. 27, 1885.	Thomas, J. T. N., "Rossie," Crosbie road south, Waterloo, Liverpool.
May 23, 1879.	Thompson, I. C., F.R.M.S., Woodstock, Waverley road, Liverpool.
Feb. 24, 1871.	Thornthwaite, W. H., Willow Bridge road, Canonbury, N.
May 23, 1884.	Tipple, A. C., 19, Stavordale road, Highbury hill, N.
June 23, 1871.	Topping, Amos, 28, Charlotte street, Caledonian road, N.
June 23, 1882.	Trinder, Stephen.
June 27, 1884.	Tress, S. C., West lodge, Clapham park, S.W.
July 24, 1868.	Tulk, John A., M.D., F.R.M.S., Cowley house, Chertsey.
July 26, 1867.	Turnbull, J., Laurel house, North hill, Highgate, N.
Aug. 24, 1877.	Turner, E. B., Francis road, Leyton, Essex.
Feb. 25, 1881.	Tyler, Charles, F.L.S., F.G.S., F.R.M.S., Elberton, New West End, Finchley Road, Hampstead, N.W.
Feb. 27, 1885.	Upton, C., "The Firs," Camscross road, Stroud, Gloucestershire.
May 25, 1877.	Veasey, R. G., Ashchurch lodge, Ashchurch road, Shepherd's bush, W.
Feb. 28, 1879.	Venables, W., 95, Elgin road, St. Peter's park, Harrow road, W.

Date of Election.	
Feb. 27, 1880.	Vereker, the Hon. J. G. P., Hamsterley Hall, Lintz green, Newcastle-on-Tyne.
May 23, 1879.	Vezey, J. J., F.R.M.S., 12, Sandbourne road, Brockley rise, S.E.
Mar. 24, 1882.	Vicars, John, 7, Hartington road, Liverpool.
June 25, 1880.	Waddington, H. J., Moreton Lodge, Bethune road, Stamford hill, N.
Mar. 27, 1885.	Wainwright, C. J., Elmhurst, East Finchley, N.
July 25, 1873.	Walker, J. S., Warwick road, Upper Clapton, E.
May 22, 1868.	Waller, J. G., F.S.A., 68, Bolsover street, Portland road, W.
Nov. 22, 1867.	Ward, F. H., M.R.C.S., F.R.M.S., Springfield house, near Tooting, S.W.
Feb. 25, 1881.	Ward, J. D., Northwood lodge, Cowes, Isle of Wight.
June 28, 1878.	Ward, R. J., Silver street, Lincoln.
Oct. 27, 1865.	Watkins, C. A., Rosemount, Greenhill road, Hampstead.
Sept. 28, 1877.	Watson, T. P., F.R.M.S., 313, High Holborn, W.C.
Sept. 26, 1884.	Watson, W., 313, High Holborn, W.C.
May 23, 1879.	Watts, The Rev. G. E., M.A., F.R.M.S., Kensworth vicarage, Dunstable, Herts.
July 24, 1874.	Webb, C. E., Wildwood lodge, North end, Hampstead, N.W.
May 24, 1867.	Weeks, A. W. G., 36, Gunter grove, West Brompton, S.W.
May 23, 1884.	West, C., 7, Park row, Blackheath, S.E.
May 26, 1882.	Western, George E., 2, Pine villas, West Hill Road, Wandsworth.
Feb. 25, 1876.	Wheeler, George, 9, Cloudesley square, Barnsbury, N.
May 23, 1879.	Wheldon, John, F.R.M.S., 58, Great Queen street, Lincoln's Inn Fields, W.C.
Feb. 26, 1886.	White, R., 43, Devonshire street, Islington, N.
May 22, 1868.	WHITE, T. CHARTERS, M.R.C.S., L.D.S., F.L.S., F.R.M.S. *(Past President)*, 32, Belgrave road, S.W.
Aug. 22, 1879.	Whittell, H. T., M.D., F.R.M.S., Board of Health, Adelaide, South Australia.

Date of Election.	
June 25, 1880.	Wickes, W. D., 32, Burlington gardens, Acton, W.
Mar. 25, 1881.	Wildy, Arthur, 48, Albion road, South Hampstead, N.W.
April 23, 1880.	Williams, Arthur, 48, Osnaburg street, Regent's park, N.W.
Mar. 24, 1871.	Williams, George, F.R.M.S., 135, Coningham road, Shepherd's bush, W.
Nov. 23, 1877.	Williams, G. S., 20, Oxford road, Kilburn, N.W.
May 22, 1885.	Williams, T., 31, High street, Kensington, W.
June 27, 1879.	Willson, James, 65, Gloucester crescent, N.W.
Feb. 22, 1867.	Wilson, Frank, 110, Long acre, W.C.
Oct. 24, 1884.	Wilson, W., 200, Dalston lane, E.
April 23, 1880.	Winney, H. J., 1, Shorter's court, Throgmorton street, E.C.
Aug. 27, 1869.	Woods, W. Fell, 1, Park hill, Forest hill, S.E.
Jan. 28, 1876.	Woollett, John, 58, Cloudesley road, Islington, N.
Oct. 25, 1867.	Worthington, Richard, Champion park, Denmark hill, S.E.
June 27, 1873.	Wrey, G. E. B., Addington house, Addington road, Reading.
Aug. 22, 1879.	Wright, B. M., 54, Guilford street, Russell square, W.C.
Jan. 25, 1878.	Yates, Robert, 64, Park street, Southwark, S.E.
June 22, 1883.	Young, William Martin, 16, Maclise road, West Kensington park, W.

NOTICE.

Members are requested to give early information to one of the Hon. Secretaries of any change of residence, so as to prevent miscarriage of Journals and Circulars.

RULES.

I.—That the Quekett Microscopical Club hold its Meetings at University College, Gower Street, on the fourth Friday Evening in every month, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee, consisting of a President, four Vice-Presidents, an Honorary Treasurer, one or more Honorary Secretaries, an Honorary Secretary for Foreign Correspondence, an Honorary Reporter, an Honorary Librarian, an Honorary Curator, and twelve other Members—six to form a quorum. That the Presidents, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and the four senior Members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant-Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in January nominations be made of Candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator be nominated by the Committee. That the nominations for Members of Committee be made by the Members on resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That a list of all nominations made as above be printed upon the ballot paper; the nominations for vacancies upon the Committee being arranged in such order as shall be determined by lot, as drawn by the President and Secretary. That at the Annual General Meeting in February all the above Officers be elected by ballot from the Candidates named in the lists, but any Member is at liberty to substitute on his ballot paper any other name or names in lieu of those nominated for the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended balloted for at the following Meeting. Three black balls to exclude.

VI.—That the Club include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of January, but that any Member elected in November or December be exempt from subscription until the following January. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in January.

IX.—That the Annual Géneral Meeting be held on the fourth Friday in February, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet, duly signed by the Auditors, shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a Conversazione.

XI.—That any Member may introduce a Visitor at any ordinary Meeting, who shall enter his name with that of the Member by whom he is introduced in a book to be kept for the purpose.

XII.—That no alteration be made in these Rules, except at an Annual General Meeting, or a special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership.

Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(On my personal knowledge.)

This Certificate was read 18

The Ballot will take place 18

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

1887,

At University College, Gower Street, W.C.,

ON THE

SECOND AND FOURTH FRIDAYS OF EVERY MONTH.

FRIDAY,	January ...	...	14	...	28
,,	February ...	...	11	...	25
,,	March ...	...	11	...	25
,,	April ...	...	8*	...	22
,,	May	...	13	...	27
,,	June... ...	...	10	...	24
,,	July	...	8	...	22
,,	August ...	...	12	...	26
,,	September ...	...	9	...	23
,,	October ...	...	14	...	28
,,	November ...	...	11	...	25
,,	December ...	...	9	...	23

The ANNUAL GENERAL MEETING will be held on Friday, February 25th, at 8 o'clock, for Election of Officers and other Business.

* Good Friday, no Meeting.

EXCURSIONS, 1887.

April 2. CHINGFORD. To meet at Liverpool Street Station.

April 23. ROYAL BOTANIC GARDENS, REGENT'S PARK. To meet at the Entrance at 3 p.m.

May 7. STAINES. To meet at Waterloo, Loop Line Station.

May 21. WOODSIDE PARK, for TOTTERIDGE, returning by Mill Hill. To meet at Broad Street Station.

June 4. WOKING. To meet at Waterloo Main Line Station.

June 18. DAY EXCURSION, WHITSTABLE. To meet at Holborn Viaduct Station, 10 a.m., or next later train. (Unless at least fifteen members notify their intention of going on this Excursion a reduction of fares cannot be obtained, and notice should be given to the Secretary of the Excursions Sub-Committee on or before June 10.)

July 2. SHEPPERTON for WALTON. To meet at Waterloo, Loop Line Station.

July 16. LOUGHTON for EPPING FOREST. To meet at Liverpool Street Station.

Sept. 3. RICHMOND. To meet at Waterloo, Loop Line Station.

Sept. 17. HAYES for KESTON. To meet at Cannon Street Station.

Oct. 1. RYE HOUSE. To meet at Liverpool Street Station.

Oct. 15. WOOD STREET for EPPING FOREST. To meet at Liverpool Street Station.

The time for departure from town, unless otherwise specified, will be the First Train after TWO o'clock.

Ed. Dadswell, J. D. Hardy, F. W. Hembry, R. T. G. Nevins, J. T. Powell, C. Rousselet, Jas. Spencer, } Excursions Sub-Committee.

Fredk. A. Parsons, Hon. Sec. Excursions Sub-Committee, 3, Osborne Road, Finsbury Park, N.

OFFICERS AND COMMITTEE.

(Elected February, 1888.)

President.

PROF. B. T. LOWNE, F.R.C.S., F.L.S., &c.

Vice-Presidents.

A. D. MICHAEL, F.L.S., F.R.M.S., &c.
PROF. C. STEWART, M.R.C.S., F.L.S., F.R.M.S., &c.
E. T. NEWTON, F.G.S., &c.
E. M. NELSON.

Committee.

W. W. REEVES, F.R.M.S.
E. DADSWELL, F.R.M.S.
A. W. STOKES, F.C.S.
H. MORLAND.
G. STURT, F.R.M.S.
F. A. PARSONS, F.R.M.S.
J. J. VEZEY, F.R.M.S.
H. J. WADDINGTON.
T. C. WHITE, M.R.C.S., L.D.S., F.R.M.S.
B. W. PRIEST.
J. G. WALLER.
F. W. HEMBRY, F.R.M.S.

Hon. Treasurer.

F. W. GAY, F.R.M.S., 113, High Holborn, W.C.

Hon. Secretary.

G. C. KAROP, M.R.C.S., F.R.M.S., 198, Holland Road, Kensington, W.

Hon. Sec. for Foreign Correspondence and Editor of Journal.

HENRY F. HAILES, 15, Westfield Road, Hornsey, N.

Hon. Reporter.

R. T. LEWIS, F.R.M.S.

Hon. Librarian.

ALPHEUS SMITH,
8, Hanover Park, Peckham, S.E.

Hon. Curator.

CHARLES EMERY,
10, New Road, Crouch End, N.

PAST PRESIDENTS.

	Elected.	
EDWIN LANKESTER, M.D., F.R.S. - -	July,	1865.
ERNEST HART - - - - - - -	„	1866.
ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.	„	1867.
„ „ „ „ - -	„	1868.
PETER LE NEVE FOSTER, M.A. - -	„	1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	„	1870.
„ „ „ „ - -	„	1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	„	1872.
„ „ „ „ - -	„	1873.
JOHN MATTHEWS, M.D., F.R.M.S. - -	„	1874.
„ „ „ „ - -	„	1875.
HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	„	1876.
„ „ „ „ - -	„	1877.
THOS. H. HUXLEY, LL.D., F.R.S., &c. - -	„	1878.
T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., &c.		1879.
T. CHARTERS WHITE, M.R.C.S., F.L.S., &c.	„	1880.
„ „ „ „ - -	„	1881.
M. C. COOKE, M.A., LL.D., A.L.S. „ - -	„	1882.
„ „ „ „ - -	„	1883.
W. B. CARPENTER, C.B., F.R.S., &c., &c. -	„	1884.
A. D. MICHAEL, F.L.S., F.R.M.S., &c. - -	„	1885.
„ „ „ „ - -	Feb.	1887.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 120, Belleville avenue, Newark, New Jersey, U.S.A.
Mar. 19, 1869.	The Rev. E. C. Bolles, Salem, Mass., U.S.A.
July 26, 1872.	S. O. Lindberg, M.D., Professor of Botany, University of Helsingfors, Finland.
July 26, 1872.	Professor Hamilton L. Smith, Hon. F.R.M.S., President of Hobart College, Geneva, New York, U.S.A.
July 23, 1875.	Lionel S. Beale, M.B., F.R.S., F.R.M.S., &c. (*Past President*), 61, Grosvenor street, W.
Sept. 22, 1876.	Frederick Kitton, Hon. F.R.M.S., &c., 8, West Kensington terrace, W.
July 25, 1879.	Dr. E. Abbe, Hon. F.R.M.S., University, Jena, Saxe Weimar, Germany.
July 23, 1880.	F. H. Wenham, C.E., 112, New Bond street, W.
Nov. 24, 1882.	Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.

LIST OF MEMBERS.

Date of Election.	
Sept. 24, 1869.	Ackland, William, L.S.A., F.R.M.S., 416, Strand, W.C.
Oct. 26, 1883.	Addiscott, C. J., Sydney Villa, St. Bildas road, Manor park, Stoke Newington, N.
Mar. 23, 1866.	Allbon, William, F.R.M.S., 37, Gloucester place, Portman square, W.
Oct. 24, 1884.	Allen, W. A., 156, Choumert road, Rye lane, Peckham, S.E.
Dec. 17, 1869.	Ames, G. A., F.R.M.S., Union Club, Trafalgar square, W.C.
Dec. 22, 1865.	Andrew, F. W., 3, Neville terrace, Onslow gardens, S.W.
June 22, 1883.	Ash, George C., 141, Maida vale, W.
July 25, 1879.	Ashbridge, Arthur, 76, Leadenhall street, E.C.
Dec. 28, 1883.	Bailey, Rev. G., F.R.M.S., The Manse, Finchingfield, Essex.
Dec. 27, 1867.	Bailey, J. W., 75, Broke road, Dalston, E.
April 24, 1868.	Baker, Charles, F.R.M.S., 244, High Holborn, W.C.
Jan. 24, 1879.	Barham, G. T., Danehurst, Hampstead, N.W.
Dec. 27, 1872.	Barnard, Herbert, 33, Portland place, W.
April 22, 1870.	Barnes, C. B., 4, Egremont villas, White Horse lane, South Norwood, S.E., and 27, Clement's lane, E.C.
July 27, 1883.	Barnes, Henry, Patschull house, Dartmouth Park avenue, N.
Dec. 23, 1887.	Barnes, W., 58, Frederick street, Gray's Inn road, W.C.
May 25, 1883.	Barratt, Thomas, Bell Moor house, Upper Heath, Hampstead, N.W.

Date of Election.	
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught square, W.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., F.R.M.S., 68, Cornhill, E.C.
May 26, 1871.	Bedwell, Judge, M.A. Cantab, West parade, Hull, Yorkshire.
Mar. 28, 1884.	Beetham, A., 14, South square, Gray's Inn, W.C.
June 25, 1886.	Bernau, F. G., "Brabant," Tulse hill, S.W.
May 22, 1868.	Berney, John, F.R.M.S., 61, North end, Croydon.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., "Avondale," Coloraine road, Blackheath, S.E.
July 23, 1886.	Bickerton, G. A., St. George's lodge, Queen's road, Richmond, Surrey.
Mar. 28, 1879.	Bird, F. E.
Feb. 23, 1866.	Blake, T., Fernside, Kent road, East Molesey, Surrey.
July 27, 1877.	Blenkinsop, B., Shord hill, Kenley, Surrey.
May 26, 1876.	Blundell, J., Stock Exchange, E.C.
Feb. 24, 1888.	Boldon, G. J., 75, Oxford road, Gunnersbury.
Dec. 27, 1881.	Bolton, J. G. E., M.R.C.S., Savanne, Mauritius.
Nov. 23, 1883.	Bostock, E., F.R.M.S., "The Radfords," Stone, Staffordshire.
Jan. 23, 1885.	Bousfield, E. C., L.R.C.P.Lond., M.R.C.S., 363, Old Kent road, S.E.
Oct. 27, 1865.	Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*Past President*), The Ferns, 303, Clapham road, S.W.
May 26, 1876.	Brigstock, J. W., "Ferntower," Manor road, Stoke Newington, N.
Mar. 25, 1887.	Broad, C. S., The Chestnuts, Harlesden, N.W.
Oct. 27, 1883.	Brown, Fredk. Wm., 35, Walterton road, St. Peter's park, Harrow road, W.
Sept. 26, 1879.	Brown, William, B.Sc., 3, Elm cottages, Middle lane, Crouch end, N.
May 22, 1868.	Brown, W. J., 17, Maple road, Anerley, S.E.
Jan. 28, 1887.	Browne, E. T., F.R.M.S., Uxbridge lodge, Uxbridge road, Shepherd's Bush, W.

Date of Election.	
May 26, 1871.	Browne, George, 45, Victoria road, Kentish town, N.W.
May 28, 1875.	Browne, J. W., Frascati, Masons hill, Bromley, Kent.
Feb. 27, 1872.	Browne, Rev. T. H., F.R.M.S., F.G.S., M.E.S., High Wycombe, Bucks.
Jan. 23, 1880.	Browne, W. R., Alder cottage, Isleworth.
June 25, 1886.	Bryant, E., "The Corellis," Anson road, Tufnell park, N.
May 22, 1885.	Buckland, H., Ivy Holt, Station road, Sidcup, Kent.
Dec. 22, 1882.	Bucknall, Edward, 16, Junction road, Highgate, N.
Oct. 28, 1887.	Buckney, T., 61, Strand, W.C.
Jan. 26, 1877.	Buffham, T. H., Hughenden villa, Comley Bank road, Walthamstow.
June 22, 1883.	Burbidge, William Henry, Stanley house, Alleyn park, Dulwich, S.E.
Aug. 22, 1879.	Burton, William, 27, Wigmore street, W.
Feb. 26, 1886.	Butcher, W. J., B.Sc., Emanuel College, Wandsworth common, S.W.
June 14, 1865.	Bywater, W. M., F.R.M.S., 5, Hanover square, W.
June 25, 1880.	Cambridge, John, Bury St. Edmunds, Suffolk.
May 23, 1879.	Carpenter, H. S., F.R.M.S., Beckington house, Weighton road, Anerley, S.E.
July 23, 1880.	Carr, Ebenezer, 26, Bromar road, Denmark park, S.E.
May 26, 1882.	Chapman, W. Ingram, 5, Hollywood villas, Melrose road, Southfields, S.W.
Dec. 27, 1878.	Chatto, Andrew, 214, Piccadilly, W.
Mar. 22, 1878.	Chester, The Dean of, The Deanery, Chester.
Nov. 27, 1874.	Chippendale, George, 4, Marco road, The Grove, Hammersmith, W.
Dec. 27, 1881.	Claremont, Claude Clarke, M.R.C.S., Millbrooke house, Hampstead road, N.W.
Feb. 23, 1883.	Clark, Joseph, F.R.M.S., Hind Hayes, Street, Somerset.
Oct. 23, 1885.	Clayton, C., Cottesloe, Chatsworth road, Croydon.

Date of Election.	
May 22, 1885.	Clinch, J. W., Lake Brewery, Douglas, Isle of Man.
May 22, 1868.	Cocks, W. G., 36, Gayhurst road, Dalston, E.
Sept. 22, 1876.	Cole, A. C., F.R.M.S., 171, Ladbroke Grove road, Notting hill, W.
Nov. 23, 1883.	Cole, Martin, 1, Maze villas, Priory park, Kew.
Jan. 25, 1867.	Coles, Ferdinand, F.L.S., F.R.M.S., 53, Brooke road, Stoke Newington common, N.
Mar. 24, 1876.	Colsell, G. D., 1, Dermody road, East Down, Lewisham, S.E.
June 14, 1865.	Cooke, M. C., M.A., LL.D., A.L.S. (*Past President*), 146, Junction road, Upper Holloway, N.
Feb. 22, 1867.	Cooper, F. W., L.R.C.S.Edin., Leytonstone, E.
June 27, 1873.	Corbett, A. L., 11, Orlando road, Clapham, S.W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., H.M.Office of Woods, Whitehall place, S.W.
Jan. 22, 1886.	Coventon, C. A., Morwenstow, West Enfield.
July 26, 1872.	Cowan, T. W., F.G.S., F.R.M.S., Avenue de la Gare, Lausanne, Switzerland.
July 22, 1887.	Cowling, R. G., 47, Dockley road, Bermondsey, S.E.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., *V.P. and Treas. Linnean Society; Sec. Royal Microscopical Society*, 5, Lansdowne road, Notting hill, W.
Dec. 23, 1870.	Crisp, J. S., F.R.M.S., Ashville, Lewin road, Streatham, S.W.
July 26, 1878.	Crockford, Wm., 2, St. Peter's road, Mile end, E.
Feb. 23, 1877.	Crofton, Edward, M.A.(Oxon.), F.R.M.S., 45, West Cromwell road, South Kensington, S.W.
June 25, 1886.	Crookshank, Prof. E. M., M.B., F.R.M.S., 24, Manchester square, W.
Sept. 26, 1884.	Crowhurst, H. A., 313, High Holborn, W.C.
June 25, 1880.	Curties, C. Lees, 244, High Holborn, W.C.
May 25, 1866.	Curties, Thomas, F.R.M.S., 244, High Holborn, W.C.
June 25, 1880.	Curties, W. Irvin, 244, High Holborn, W.C.
Sept. 26, 1879.	Curtis, Charles, 29, Baker street, Portman sq., W.
April 22, 1881.	Cutting, W. M., 1, Curtain road, E.C.

Date of Election.

Aug. 27, 1886. Daddo, W. S., M.A., 59, Southborough road, South Hackney, E.

Jan. 22, 1875. Dadswell, E., F.R.M.S., 38, Montrell road, Streatham hill, S.W.

Nov. 23, 1877. Dallas, W. S., F.L.S., &c., the Geological Society, Burlington house, Piccadilly, W.

Feb. 23, 1883. Dallinger, Rev. W. H., LL.D., F.R.S., F.R.M.S. (*President R.M.S.*), Wesley College, Sheffield.

May 23, 1879. Dallmeyer, T. R., 19, Bloomsbury street, W.C.

Mar. 22, 1878. Darke, Edward, 16, Rochester terrace, Camden road, N.W.

Aug. 23, 1883. Davis, H., 108, Sandringham road, Dalston, E.

May 23, 1879. Dawson, W., F.R.M.S., 24, Abbeygate street, Bury St. Edmunds, Suffolk.

May 28, 1875. Dean, Arthur (*Hon. Sec. East Lond. Mic. Soc.*), 57, Southborough road, South Hackney, E.

Feb. 28, 1879. Debenham, E. H., 9, Mincing lane, E.C.

Jan. 24, 1879. Deby, Julien, C.E., F.R.M.S., 31, Belsize avenue, St. John's Wood, N.W.

Nov. 24, 1876. Despointes, Francis, 16, St. George's square, Regent's park road, N.W.

Oct. 25, 1878. Dowler, Captain F. E., 28, Albermarle street, W.

May 25, 1883. Drake, C. A., The Distillery, Three Mill lane, Bromley-by-Bow.

July 25, 1879. Driver, Alfred, 30, Leigham court road west, Streatham, S.W.

Oct. 25, 1872. Dunning, C. G., 55, Camden park road, N.W.

Sept. 22, 1865. Durham, A. E., F.R.C.S., F.L S., F.R.M.S., &c. (*Past President*), 82, Brook street, Grosvenor square, W.

July 27, 1883. Durrand, Alexander, F.R.M.S.,

Sept. 25, 1868. Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.

June 28, 1867. Edmonds, R., Royal Arsenal, Woolwich, S.E.

July 25, 1884. Ellis, J. H., The Lindens, Geraldine road, Wandsworth, S.W.

May 26, 1876. Emery, Charles (*Hon. Curator*), 10, New road, Crouch end, N.

Date of Election.

May 26, 1881. Enock, Frederick, 11, Parolles road, Upper Holloway, N.

Feb. 28, 1879. Epps, Hahnemann, F.R.M.S., 95, Upper Tulse hill, Brixton, S.W.

Feb. 21, 1884. Epps, J., jun., "The Homestead," Ross road, South Norwood hill, S.E.

July 25, 1873. Fase, Rev. H. J., 8, Dents road, Wandsworth common, S.W.

June 25, 1875. Faulkner, Henry, jun., Fernwood, Roehampton park, S.W.

Jan. 28, 1876. Faulkner, John, 20, Mornington crescent, N.W.

Aug. 25, 1882. Field, W. H., 39, Crouch Hall road, Crouch end, N.

Feb. 27, 1880. Fieldwick, Alfred, jun., 284, Dalston lane, Hackney, E.

July 22, 1881. Firth, W. A., 95, City View terrace, Falls road, Belfast.

July 26, 1867. Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh house, Highbury New park, N.

Feb. 24, 1882. Fitch, J. N., 17, Eversholt street, Camden Town, N.W.

Feb. 24, 1888. Fletcher, W. W., 24, Woodsome road, Highgate road, N.W.

Nov. 28, 1879. Forster, William, jun., Cleveland road, Woodford, Essex.

Mar. 24, 1871. Foulerton, John, M.D., 44, Pembridge villas, Bayswater, W.

Oct. 24, 1884. Fowler, C., Estelle road, Mansfield road, Gospel Oak, N.W.

Dec. 28, 1866. Fox, C. J., 65, Faubourg Poissonnière, Paris.

Nov. 26, 1875. Freckelton, Rev. T. W., F.R.M.S., 28A, Lonsdale square, Islington, N.

June 23, 1871. Freeman, H. E., 104, Shaftesbury road, Crouch hill, N.

May 22, 1868. Fryer, G. H.

July 23, 1880. Funston, James, 93, Finsbury pavement, E.C.

Mar. 25, 1870. Garden, R. S., 42, Carlton hill, St. John's wood, N.W.

Date of Election.	
Jan. 23, 1885.	Garner, J. B., 75, Sparkenhoe street, Leicester.
April 23, 1880.	Gates, G. W. H., 21, Lombard street, E.C.
July 7, 1865.	Gay, F. W., F.R.M.S. *(Hon. Treasurer)*, 113, High Holborn, W.C.
July 26, 1867.	George, Edward, F.R.M.S., Vernon house, Westward park, Forest hill, S.E.
April 27, 1877.	Gilbertson, Henry, Mangrove house, Hertford.
Oct. 27, 1876.	Gilburt, W. H.
Feb. 24, 1888.	Gill, G. J., Miskin road, Dartford, Kent.
Nov. 28, 1879.	Goodinge, A. C., 119, High Holborn, W.C.
April 26, 1872.	Goodinge, J. W., F.R.G.S., F.R.M.S., 119, High Holborn, W.C.
Nov. 23, 1877.	Goodwin, William, 19, Prospero road, Upper Holloway, N.
July 27, 1883.	Goold, Ernest H., C.E., F.Z.S., M.R.I., 4, Dane's Inn, Strand, W.C.
Dec. 23, 1887.	Goslett, F., 20, Fisherton street, Sailsbury.
Mar. 27, 1866.	Gray, S. O., Bank of England, E.C.
Oct. 23, 1868.	Greenish, Thomas, F.R.M.S., 20, New street, Dorset square, N.W.
Oct. 23, 1868.	Gregory, H. R., 7, Quality court, Chancery lane.
Feb. 25, 1887.	Gross, W., 23, York place, Portman square, W.
Jan. 28, 1887.	Grove, E., F.R.M.S., Seabank, West Worthing, Sussex.
July 24, 1868.	Groves, Prof. J. W., F.R.M.S., 90, Holland road, Kensington, W.
July 24, 1868.	Grubbe, E. W., C.E., 5, Chepstow place, Bayswater, W.
Jan. 27, 1871.	Guimaraens, A. de Souza, F.R.M.S., 52, Lowden road, Herne hill, S.E.
Sept. 28, 1877.	Hagger, John, Repton school, Burton-on-Trent.
Feb. 25, 1881.	Haigh, William, Tempsford villa, Uxbridge road, Ealing, W.
June 14, 1865.	Hailes, H. F. (*Hon. Secretary for Foreign Correspondence and Editor*), 15, Westfield road, Hornsey, N.
Aug. 26, 1870.	Hailstone, R. H., 91, Adelaide road, N.W.
Feb. 23, 1867.	Hainworth, William, 105, Darenth road, Stamford hill, N.

Date of Election.	
Dec. 28, 1866.	Hallett, R. J., 123, Seymour street, Euston square, N.W.
Feb. 22, 1869.	Hammond, A., F.L.S., 5, Swiss terrace, Elmers end road, Beckenham, S.E.
Oct. 22, 1886.	Hampton, W., 38, Lichfield street, Hanley, Staffordshire.
June 25, 1880.	Hancock, H. S. H., 50, Springdale road, Stoke Newington, N.
Feb. 24, 1882.	Harding, J. H., 4, Finsbury square, E.C.
July 25, 1879.	Hardingham, G. G., F.R.M.S., F.R.B.S., 33, St. George's square, S.W.
Jan. 23, 1874.	Hardy, J. D., F.R.M.S., 73, Clarence road, Clapham, E., and 4, Lombard street, E.C.
Sept. 28, 1866.	Harkness, W., F.R.M.S., Laboratory, Somerset house, W.C.
Nov. 27, 1885.	Harris, F. W., Hilltop villa, Shootup hill road, Cricklewood, N.W.
April 23, 1875.	Harrison, James, 150, Akerman road, North Brixton, S.W.
May 23, 1884.	Havers, J. C., F.R.M.S., Joyce Grove, Nettlebed, Henley-on-Thames.
Mar. 28, 1879.	Hawkins, C. E., H.M. Geological Survey, Jermyn street, S.W.
June 28, 1867.	Hawksley, T. P., 97, Adelaide road, N.W.
June 22, 1883.	Hazlewood, Jas. Edmund, F.R.M.S., 3, Lennox place, Brighton.
Aug. 23, 1872.	Hembry, F. W., F.R.M.S., Sussex Lodge, Sidcup, Kent.
June 26, 1868.	Henry, A. H., 73, Redcliffe gardens, S.W.
Feb. 26, 1886.	Hewlett, R. T., Sandhill house, King's farm, Richmond, Surrey.
April 25, 1884.	Higgins, J., London University, Burlington gardens, W.
June 22, 1877.	Hill, R. W., 41, Lothbury, E.C.
Feb. 25, 1887.	Hillier, J. T., 4, Chapel place, Ramsgate.
Sept. 24, 1869.	Hilton, T. D., M.D., Upper Deal, Kent.
Sept. 28, 1866.	Hind, F. H. P., 11, Copthall court, Throgmorton street, E.C.
May 22, 1874.	Hind, George, 244, High Holborn, W.C.

Date of Election.	
Feb. 26, 1875.	Holford, Christopher, Bounty Office, Dean's yard, Westminster, S.W.
Jan. 23, 1880.	Holland, C. F., 184, Brooke road, Upper Clapton, E.
Nov. 26, 1880.	Hopkins, Robert, Shearn villa, Walthamstow, Essex.
Oct. 26, 1866.	Horncastle, Henry, Cobham, near Woking station.
May 22, 1874.	Hovenden, C. W., F.R.M.S., 95, City road, E.C.
April 26, 1867.	Hovenden, Frederick, F.R.M.S., Glenlea, Thurlow park road, Dulwich, S.E.
Jan. 27, 1888.	How, W. S., 75, Great Portland street, W.
Oct. 27, 1876.	Howard, D., 60, Belsize park, N.W.
Oct. 25, 1878.	Howling, W. E., Crowley's Brewery, Alton, Hants.
Sept. 23, 1887.	Hughes, F. T., 48, Malvern road, Kilburn, N.W.
May 28, 1886.	Hughes, W., 32, Heathland road, Stoke Newington, N.
Jan. 23, 1880.	Hunt, Frederick, York lodge, Stamford hill, N.
Dec. 22, 1876.	Hunter, J. J., 20, Cranbourne street, W.C.
July 25, 1873.	Hurst, J. T., 1, Raymond villas, Geraldine road, Wandsworth, S.W.
June 28, 1878.	Huxley, Prof. T. H., F.R.S., &c. (*Past President*), Science Schools, South Kensington, S.W.
May 24, 1867.	Ingpen, J. E., F.R.M.S, 7, The Hill, Putney, S.W.
Dec. 17, 1875.	Jackson, C. L., F.L.S., F.Z.S., F.R.M.S, Hill Fold, Sharples, Bolton.
July 24, 1868.	Jackson, F. R., Culver cottage, Slindon, Arundel, Sussex.
June 25, 1880.	Jacques, Walter, 2, Fenchurch buildings, E.C.
Aug. 25, 1882.	Jakeman, Christopher, 72, South street, Greenwich.
Feb. 27, 1885.	Jaques, E. K., 36, Old Gravel lane, St. George's, E.
June 14, 1865.	Jaques, Edward, B.A., H.M. Office of Woods, Whitehall place, S.W.

Date of Election.	
Feb. 21, 1884.	Jennings, A. V., 8, Broadhurst gardens, South Hampstead, N.W.
July 24, 1868.	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 8, Broadhurst gardens, South Hampstead, N.W.
Feb. 24, 1871.	Johnson, M. Hawkins, F.G.S., 379, Euston road, N.W.
Mar. 24, 1871.	Johnstone, James, Y Coed, Stroud, Gloucestershire.
Feb. 28, 1873.	Jones, G. J., Wheelgate, Malton, Yorks.
May 23, 1873.	Karop, G. C., M.R.C.S., F.R.M.S., &c. (*Hon. Secretary*), 198, Holland road, Kensington, W.
July 25, 1884.	Kern, J. J., Fern Glen, Selhurst park, South Norwood, S.E.
Mar. 19, 1869.	Kilsby, T. W., 4, Brompton villas, Edmonton.
April 22, 1881.	King, H. W., The Cedars, Upper Park road, New Southgate, N.
Feb. 28, 1873.	Kitsell, F. J., 24, St. Stephen's avenue, Goldhawk road, Shepherd's Bush, W.
Mar. 23, 1877.	Kluht, H. J., 44, Norfolk terrace, Bayswater, W.
Jan. 24, 1879.	Lancaster, A. H., 5, Campden hill gardens, Kensington, W.
Mar. 22, 1867.	Lancaster, Thomas, Bownham house, Stroud, Gloucestershire.
Nov. 26, 1880.	Larkin, R. J., 207, Piccadilly, W.
Feb. 24, 1888.	La Thangue, R., 66, Colverstone crescent, Hackney, E.
June 25, 1869.	Layton, C. E., 12, Upper Hornsey rise, N.
Aug. 28, 1868.	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), 6, Sussex place, Regent's park, N.W.
Mar. 19, 1869.	Lee, Henry, F.L.S., F.R.M.S., &c. (*Past President*), Renton house, 343, Brixton road, S.W.
July 25, 1876.	Le Pelley, C., 84, St. Thomas' road, Seven Sisters road, N.
Nov. 25, 1887.	Lewer, J. J., 20, Crossfield road, Belsize, N.W.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 28, Mount Park crescent, Ealing, W.

Date of Election.

Jan. 28, 1887. Lightwood, A. S., 45, Roderick road, Mansfield road, N.

June 26, 1868. Lindley, W. H., jun., 29, Blittersdorffs platz, Frankfort-on-Maine.

Nov. 27, 1885. Lloyd, F. G., Westleigh, Watford, Herts.

May 26, 1871. Locke, John, 16, Georgiana street, Camden town, N.W.

Nov. 24, 1866. Lovibond, J. W., F.R.M.S., St. Anne street, Salisbury.

Sept. 22, 1866. Lovick, T., 53, Queen's crescent, Haverstock hill, N.W.

Sept. 23, 1887. LOWNE, B. T., F.R.C.S., F.L.S., &c. (*President*), 65, Cambridge gardens, Notting hill, W.

Jan. 22, 1886. Lyons, A. W., 25, Bessborough gardens, S.W.

Nov. 23, 1866. McIntire, S. J., F.R.M.S., 14, Hetley road, Uxbridge road, Shepherd's Bush, W.

Jan. 23, 1880. Mackenzie, James, Warden villa, Uxbridge road, Ealing, W.

April 27, 1883. McManis, T. J., 95, Almack road, Clapton, E.

Jan. 24, 1884. Macrae, A. C., M.D., 119, Westbourne terrace, Hyde Park, W.

May 25, 1883. Mainland, G. E., F.R.M.S., Glenthorp, Woodside lane, North Finchley, N.

May 25, 1883. Mais, H. T. Coathorpe, M.I.C.E., Engineer in Chief, Adelaide, South Australia (care of T. Curties, 244, High Holborn, W.C.).

Sept. 27, 1872. Manning, His E. the Cardinal Archbishop, Archbishop's house, Westminster, S.W.

July 27, 1883. Mansfield, Edward Joseph, *Graphic* Office, 190, Strand, W.C.

Jan. 23, 1880. Martin, Francis, R.N., Shrub cottage, Fairfield road, Old Charlton, Kent.

April 26, 1867. Matthews, G. K., St. John's lodge, Beckingham, Kent.

May 26, 1871. May, J. W., F.R.M.S., Arundel House, Percycross, Fulham, S.W.

Feb. 25, 1876. May, W. R., 109, Queen's road, Dalston, E.

Feb. 28, 1879. Menzies, James, 149, Brecknock road, N.W.

Date of Election.	
May 22, 1874.	Messenger, G. A., Lloyds, E.C.
July 27, 1877.	MICHAEL, A. D., F.L.S., F.R.M.S. (*Vice-President*), Cadogan Mansions, Sloane square, Chelsea, S.W.
May 28, 1880.	Miles, Andrew, 19, Commercial road, Camberwell, S.E.
July 7, 1865.	Millett, F. W., F.R.M.S., Marazion, Cornwall.
Sept. 22, 1882.	Moore, George, 7, Draper's gardens, Throgmorton street, E.C.
July 26, 1878.	Morland, Henry, Cranford, near Hounslow.
Jan. 24, 1879.	Murray, James, Osborne House, 271, Goldhawk road, Shepherd's Bush, W.
Feb. 22, 1878.	Needham, S. H., F.R.G.S., F.G.S., 33, Somerfield road, Finsbury park, N.
Mar. 24, 1876.	NELSON, E. M. (*Vice-President*), Cleve house, West End lane, West Hampstead, N.W.
Mar. 24, 1871.	Nelson, James, 142, Brixton road, S.W.
Nov. 25, 1881.	Nevins, R. T. G., F.R.M.S., Pembroke lodge, Hildenborough, Tunbridge.
Jan. 26, 1872.	NEWTON, E. T., F.G.S., (*Vice-President*), Geological Museum, Jermyn street, S.W.
Feb. 27, 1880.	Niven, George, Erkingholme, Coolhurst road, Crouch end, N.
May 22, 1874.	Nixon, P. C., F.R.M.S., Oporto, Portugal.
Aug. 26, 1881.	Northey, M. D., 4, Lower Brighton terrace, Surbiton.
Jan. 24, 1879.	Offord, J. M., F.R.M.S., 15, Loudoun road, St. John's Wood, N.W.
Dec. 22, 1876.	Ogilvy, C. P., F.L.S., Sizewell house, Leiston, near Saxmundham, Suffolk.
May 24, 1878.	O'Hara, Lt.-Col. Richard, F.R.M.S. (late Royal Artillery), West Lodge, Galway.
Dec. 28, 1883.	Oliver, J., 123, Stamford street, S.E.
June 23, 1882.	Ollard, John Alex., F.R.M.S., 38, Gracechurch street, E.C.
Dec. 27, 1867.	Oxley, Frederick, F.R.M.S., 8, Crosby square, Bishopsgate street, E.C.

Date of Election.	
Feb. 25, 1887.	Paine, F. G., The School House, Guilsborough, Northampton.
July 24, 1885.	Parker, J. A. D., Sunny hill, Camden park, Chislehurst.
Mar. 27, 1885.	Parritt, H. W., 103, Camden street, Camden town, N.W.
Oct. 27, 1871.	Parsons, F. A., F.R.M.S., 90, Leadenhall street, E.C.
Feb. 25, 1887.	Patterson, G., 85, Carlton road, Tuffnell Park, N.
July 23, 1886.	Paul, R., Broadway, Ealing, W.
April 23, 1875.	Peal, C. N., F.R.M.S., Fernhurst, Mattock lane, Ealing, W.
July 22, 1887.	Pearce, G., Brabourne Haigh, Highwood hill, N.W.
May 24, 1867.	Pearson, John, 3, Westbourne grove, W.
July 22, 1881.	Perigal, Henry, F.R.A.S., F.R.M.S., 9, North crescent, Bedford square, W.C.
May 28, 1886.	Peterborough, The Bishop of, The Palace, Peterborough.
Dec. 23, 1887.	Pigott, G. W. Royston, M.A., M.D., F.R.S., Annandale, Eastbourne, Sussex.
May 23, 1879.	Pilcher, W. J., F.R.C.S., &c., Boston, Lincolnshire.
June 24, 1881.	Pilley, J. J., F.R.M.S., Old College, Dulwich.
Jan. 22, 1869.	Pillischer, Moritz, F.R.M.S., 88, New Bond street, W.
Sept. 27, 1878.	Plomer, G. D., F.R.M.S., 48, Springfield road, St. John's Wood, N.W.
Nov. 23, 1883.	Plowman, T., jun., Nystuen lodge, Bycullah park, Enfield.
Sept. 28, 1877.	Pocklington, Henry, F.R.M.S., 20, Park road, Leeds.
July 24, 1885.	Porter, J. L. M., 8, Wood vale, Forest hill, S.E.
Nov. 23, 1866.	Potter, George, F.R.M.S., 66, Grove road, Holloway, N.
Jan. 25, 1878.	Potts, R. A., 26, South Audley street, W.
June 24, 1881.	Potts, William, Winchester house, Old Broad street, E.C.

Date of Election.	
June 22, 1866.	Powe, I., 76, St. George's street, Richmond, Surrey.
Aug. 25, 1882.	Powell, George, 86, Avondale square, S.E.
April 25, 1879.	Powell, H. P., Mill Platt, Isleworth.
May 26, 1876.	Powell, J. T., 32, Dunlace road, Lower Clapton, E.
July 7, 1865.	Powell, Thomas H., F.R.M.S., 18, Doughty street, Mecklenburg square, W.C.
June 27, 1873.	Priest, B. W., 22, Parliament street, S.W.
May 23, 1879.	Pritchard, J. D., Crymlyn Burrows, near Swansea.
July 26, 1867.	Pritchett, Francis, Clifford house, South Norwood park, S.E.
Feb. 25, 1881.	Probyn, Clifford, 55, Grosvenor street, W.
April 23, 1868.	Quekett, A. E., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, A. J. S., 51, Warwick road, Maida hill, W.
April 23, 1868.	Quekett, Rev. Wm., The Rectory, Warrington.
Feb. 23, 1866.	Quick, G. E., 74, Long lane, Bermondsey, S.E.
Oct. 26, 1866.	Rabbits, W. T., Irongates, Dacres road, Forest hill, S.E.
June 25, 1875.	Radford, W. S., M.D., F.R.M.S., Sidmouth.
Oct. 26, 1866.	Ramsden, Hildebrand, M.A. (Cantab.), F.L.S., F.R.M.S., 26, Upper Bedford place, Russell square, W.C.
Aug. 28, 1868.	Rance, T. G., Elmside, Bickley, Kent.
June 24, 1881.	Ransom, F., Fairfield, Hitchin.
Dec. 27, 1878.	Reed, J. M., Sidmouth house, South park, Ilford, E.
June 22, 1877.	Reed, J. W., F.R.G.S., 17, Colebrooke road, Islington, N.
June 27, 1873.	Reeve, Frederick, 113, Clapham road, S.W.
July 7, 1865.	Reeves, W. W., F.R.M.S., 32, Geneva road, Brixton, S.W.
Oct. 28, 1881.	Reynolds, W. P., 74, King William street, E.C.
June 25, 1886.	Richardson, S., 73, Normanton road, Derby.
Mar. 25, 1887.	Robinson, I., Hertford.
May 22, 1868.	Rogers, John, F.R.M.S., 4, Tennyson street, Nottingham.
May 22, 1868.	Roper, Freeman, C.S., F.L.S., F.R.M.S., F.G.S., Palgrave house, Eastbourne, Sussex.

Date of Election.	
June 23, 1876.	Roper, H. J., F.R.M.S., 7, Carlton grove, Peckham, S.E.
Oct. 27, 1876.	Roper, Robert, Avisford, Blakehall road, Wanstead, E.
Jan. 24, 1884.	Rosseter, T. B., F.R.M.S., Fleur de Lis, Canterbury.
Jan. 26, 1883.	Rousselet, Charles, 308, Regent street, W.
July 24, 1868.	Rowe, James, jun., M.R.C.V.S., 65, High street, Marylebone, W.
April 24, 1885.	Russell, A. H., 10, Cleveland gardens, W.
Oct. 27, 1865.	Russell, James, 10, High street, Shoreditch, E.
May 22, 1868.	Russell, T. D., Coningsby villas, Rosendale road, West Dulwich, S.E.
Feb. 22, 1867.	Rutter, H. L., 24, Crownhurst road, Angel road, Brixton, S.W.
Nov. 22, 1878.	Sabel, E. E., 6, Grove road, Clapham park, S.W.
Dec. 17, 1869.	Salmon, John, 24, Seymour street, Euston square, N.W.
Dec. 28, 1877.	Sands, Charles, 5, Woburn place, Russell square, W.C.
Nov. 28, 1884.	Sanford, P. G., F.C.S., Blandford lodge, Streatham, S.W.
June 27, 1879.	Sawyer, G. D., F.R.M.S., 55, Buckingham place, Brighton.
Feb. 27, 1880.	Schulze, Adolf, F.R.M.S., 2, Doune gardens, Kelvinside, Glasgow, N.B.
Mar. 24, 1882.	Selby, H., 94, Wharton road, West Kensington park, W.
Mar. 26, 1886.	Sercombe, H., 67, Lombard street, E.C.
July 27, 1868.	Sewell, Richard, Ashmare House, Keston, Kent.
May 25, 1883.	Sharer, W. R., 60, Thornhill square, Barnsbury, N.
July 23, 1880.	Shaw, H. V., Fir Croft, Keymer, Hurstpierpoint, Sussex.
Oct. 22, 1869.	Shaw, W. F., Mosshall grove, Finchley, N.
May 26, 1876.	Shepheard, Thomas, F.R.M.S., Kingsley lodge, Chester.
May 26, 1871.	Sigsworth, J. C., F.R.M.S., 54, Portland road, Notting hill, W.

Date of Election.

June 27, 1873.	Simmonds, J. E., Royal Exotic Nursery, King's road, Chelsea, S.W.
Aug. 23, 1867.	Simmons, J. J., L.D.S., 18, Burton crescent, Euston road, N.W.
Oct. 28, 1881.	Simons, W. V., Nilgiri house, 5, Baldwyn crescent, Camberwell, S.E.
July 23, 1886.	Simpson, D. G., 200, The Grove, Denmark hill, S.E.
May 26, 1876.	Simpson, Edward, 24, Grummant road, Peckham road, S.E.
Feb. 23, 1883.	Simpson, Isaac, 1, Junction road, Upper Holloway, N.
Nov. 23, 1877.	Simpson, T., Fernymere, Castlebar, Ealing, W.
Dec. 28, 1866.	Slade, J., F.G.S., Chappel road, Bexley heath, Kent.
Oct. 23, 1868.	Smart, William, 27, Aldgate, E.
May 25, 1866.	Smith, Alpheus (*Hon. Librarian*), 8, Hanover park, Peckham, S.E.
April 23, 1880	Smith, A. S., Silvermere, Cobham, Surrey.
Mar. 25, 1870.	Smith, F. L., 3, Grecian cottages, Crown hill, Norwood, S.E.
June 27, 1873.	Smith, G. J., F.R.M.S., 73, Farringdon street, E.C.
Oct. 26, 1877.	Smith, Samuel, Maldon house, 17, Sydenham park, S.E.
April 22, 1887.	Smith, T. F., 12, Campdale road, Tufnell park, N.
Mar. 24, 1882.	Smith, W. Dalton, 2, Craigs court, Charing Cross, S.W.
Aug. 23, 1872.	Smith, W. S., 30, Loraine road, Holloway, N.
Aug. 22, 1884.	Smithson, T. S., Facit, Rochdale.
July 24, 1885.	Snelgrove, A. G., Leighton villa, Upper Holloway, N.
Nov. 28, 1884.	Snell, F. A., The Chestnuts, Chislehurst.
April 24, 1868.	Snellgrove, W., 58, Cranfield road, Wickham park, S.E.
Sept. 22, 1865.	Southwell, C., Surrey lodge, Child's hill, N.W.
May 26, 1876.	Southwell, C. W., 227, Great Cheetham street, Higher Broughton, Manchester.
May 22, 1874.	Spencer, James, F.R.M.S., 121, Lewisham road, Lewisham.

Date of Election.	
Sept. 25, 1885.	Spriggs, A., Bank of England, E.C.
Mar. 27, 1885.	Squire, P. W., F.L.S., F.C.S., 40, Avenue road, Regent's park, N.W.
Feb. 27, 1885.	Stephenson, J. W., F.R.A.S., F.R.M.S., 186, Clapham road, S.W.
Nov. 27, 1885.	Stevenson, G. T., Cunningham place, St. John's Wood, N.W.
Aug. 24, 1866.	Steward, J. H., F.R.M.S., 406, Strand, W.C.
June 22, 1877.	STEWART, CHARLES, M.R.C.S., F.L.S., F.R.M.S., &c. (*Vice-President*), Royal College Surgeons, Lincoln's Inn Fields, W.C.
May 23, 1879.	Stocken, James, 21, Endsleigh gardens, N.W.
June 24, 1881.	Stokes, A. W., F.C.S., Laboratory, Vestry hall, Paddington, W.
May 23, 1879.	Stubbins, John, F.G.S., F.R.M.S., Inglebank, Headingley, Leeds.
Sept. 23, 1881.	Sturt, Gerald, F.R.M.S., 27, Gordon square, W.C.
July 7, 1865.	Suffolk, W. T., F.R.M.S., Petersfield, St. Julian's farm road, West Norwood, S.E.
June 24, 1870.	Swain, Ernest, 17, Tadmor street, Shepherd's bush, W.
Nov. 24, 1866.	Swansborough, E., 20, John street, Bedford row, W.C.
Feb. 26, 1886.	Swanson, A. J., 112, Cheapside, E.C.
Dec. 17, 1875.	Swift, M. J., 81, Tottenham court road, W.C.
Jan. 23, 1880.	Symons, W. H., F.C.S., F.R.M.S., 130, Fellowes road, South Hampstead, N.W.
Feb. 25, 1887.	Tait, A. F., 77, Queen street, E.C.
July 27, 1877.	Tanqueray, A. C., Reid's Brewery, Theobald's road, E.C.
Nov. 28, 1879.	Tasker, J. G., 30, Junction road, Upper Holloway, N.
May 22, 1868.	Tatem, J. G., Russell street, Reading.
Feb. 24, 1888.	Taylor, W. W., "The Buttercups," Sutton, Surrey.
Aug. 23, 1878.	Teasdale, Washington, F.R.M.S., Rosehurst, Headingley, Leeds.
Feb. 24, 1888.	Tebbs, H. V., F.R.M.S., 1, St. John's gardens, Notting Hill, W.

Date of Election.

Feb. 24, 1888. Telfer, J. J., Aldborough Lodge, Amhurst park, Stamford Hill, N.

Dec. 22, 1865. Terry, John, F.R.M.S., 8, Hopton road, Coventry park, Streatham, S.W.

May 23, 1879. Thompson, I. C., F.R.M.S., Woodstock, Waverley road, Liverpool.

Feb. 24. 1871. Thornthwaite, W. H., Willow Bridge road, Canonbury, N.

June 27, 1884. Tress, S. C., West lodge, Clapham park, S.W.

July 24, 1868. Tulk, John A., M.D., F.R.M.S., Cowley house, Chertsey.

July 26, 1867. Turnbull, J., Laurel house, North hill, Highgate, N.

Aug. 24, 1877. Turner, E. B., Francis road, Leyton, Essex.

Feb. 25, 1881. Tyler, Charles, F.L.S., F.G.S., F.R.M.S., Elberton, New West end, Finchley road, Hampstead, N.W.

Feb. 27, 1885. Upton, C., "The Firs," Camscross road, Stroud, Gloucestershire.

May 25, 1877. Veasey, R. G., Ashchurch lodge, Ashchurch road, Shepherd's bush, W.

Feb. 28, 1879. Venables, W., 96, Shirland road, St. Peter's park, Harrow road, W.

Feb. 27, 1880. Vereker, the Hon. J. G. P., Hamsterley hall, Lintz green, Newcastle-on-Tyne.

May 23, 1879. Vezey, J. J., F.R.M.S., 12, Sandbourne road, Brockley rise, S.E.

Mar. 24, 1882. Vicars, John, 7, Hartington road, Liverpool.

June 25, 1880. Waddington, H. J., Moreton lodge, Bethune road, Stamford hill, N.

Mar. 27, 1885. Wainwright, C. J., Elmhurst, East Finchley, N.

July 25, 1873. Walker, J. S., Warwick road, Upper Clapton, E.

May 22, 1868. Waller, J. G., F.S.A., 68, Bolsover street, Portland road, W.

Nov. 22, 1867. Ward, F. H., M.R.C.S., F.R.M.S., Springfield house, near Tooting, S.W.

Date of Election.	
Feb. 25, 1881.	Ward, J. D., Northwood lodge, Cowes, Isle of Wight.
June 28, 1878.	Ward, R. J., Silver street, Lincoln.
Sept. 28, 1877.	Watson, T. P., F.R.M.S., 313, High Holborn, W.C.
Sept. 26, 1884.	Watson, W., 313, High Holborn, W.C.
May 23, 1879.	Watts, The Rev. G. E., M.A., F.R.M.S., Kensworth vicarage, Dunstable, Beds.
July 24, 1874.	Webb, C. E., Wildwood lodge, North end, Hampstead, N.W.
May 24, 1867.	Weeks, A. W. G., 36, Gunter grove, West Brompton, S.W.
May 23, 1884.	West, C., F.R.M.S., 7, Park row, Blackheath, S.E.
May 26, 1882.	Western, G., F.R.M.S., 2, Lime villas, West Hill road, Wandsworth, S.W.
Oct. 28, 1887.	Westerton, W. C., 4, Denmark terrace, High road, Chiswick.
Feb. 25, 1876.	Wheeler, George, 9, Cloudsley square, Barnsbury, N.
May 23, 1879.	Wheldon, John, F.R.M.S., 58, Great Queen street, Lincoln's Inn Fields, W.C.
June 24, 1887.	White, F. W., 92, Gipsy hill, S.E.
Feb. 26, 1886.	White, R., 43, Devonshire street, Islington, N.
May 22, 1868.	White, T. Charters, M.R.C.S., L.D.S., F.L.S., F.R.M.S. (*Past President*), 32, Belgrave road, S.W.
Aug. 22, 1879.	Whittell, H. T., M.D., F.R.M.S., Board of Health, Adelaide, South Australia.
June 25, 1880.	Wickes, W. D., 32, Burlington gardens, Acton, W.
Mar. 25, 1881.	Wildy, Arthur, 48, Albion road, South Hampstead, N.W.
April 23, 1880.	Williams, Arthur, 48, Osnaburg street, Regent's park, N.W.
Mar. 24, 1871.	Williams, George, F.R.M.S., 135, Coningham road, Shepherd's bush, W.
Nov. 23, 1877.	Williams, G. S., 20, Oxford road, Kilburn, N.W.

Date of Election.	
May 22, 1885.	Williams, T., 31, High street, Kensington, W.
June 27, 1879.	Willson, James, 65, Gloucester crescent, N.W.
Feb. 22, 1867.	Wilson, Frank, 110, Long acre, W.C.
June 24, 1887.	Wilson, W. T., Coleshill house, Berkhampstead.
April 23, 1880.	Winney, H. J., 1, Shorter's court, Throgmorton street, E.C.
Aug. 27, 1869.	Woods, W. Fell, 1, Park hill, Forest hill, S.E.
Jan. 28, 1876.	Woollett, John, 58, Cloudsley road, Islington, N.
Oct. 25, 1867.	Worthington, Richard, Champion park, Denmark hill, S.E.
June 27, 1873.	Wrey, G. E. B., Addington house, Addington road, Reading.
Aug. 22, 1879.	Wright, B. M., 54, Guildford street, Russell square, W.C.
Jan. 25, 1878.	Yates, Robert, 64, Park street, Southwark, S.E.
June 22, 1883.	Young, William Martin, 16, Maclise road, West Kensington park, W.

NOTICE.

Members are requested to give early information to one of the Hon. Secretaries of any change of residence, so as to prevent miscarriage of Journals and Circulars.

RULES.

I.—That the Quekett Microscopical Club hold its Meetings at University College, Gower Street, on the fourth Friday Evening in every month, except July and August, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee, consisting of a President, four Vice-Presidents, an Honorary Treasurer, one or more Honorary Secretaries, an Honorary Secretary for Foreign Correspondence, an Honorary Reporter, an Honorary Librarian, an Honorary Curator, and twelve other Members—six to form a quorum. That the Presidents, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and the four senior Members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant-Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in January nominations be made of Candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator be nominated by the Committee. That the nominations for Members of Committee be made by the Members on resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That a list of all nominations made as above be printed upon the ballot paper; the nominations for vacancies upon the Committee being arranged in such order as shall be determined by lot, as drawn by the President and Secretary. That at the Annual General Meeting in February all the above Officers be elected by ballot from the Candidates named in the lists, but any Member is at liberty to substitute on his ballot paper any other name or names in lieu of those nominated for the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended balloted for at the following Meeting. Three black balls to exclude.

VI.—That the Club include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of January, but that any Member elected in November or December be exempt from subscription until the following January. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in January.

IX.—That the Annual General Meeting be held on the fourth Friday in February, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet, duly signed by the Auditors, shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a Conversazione.

XI.—That any Member may introduce a Visitor at any ordinary Meeting, who shall enter his name with that of the Member by whom he is introduced in a book to be kept for the purpose.

XII.—That no alteration be made in these Rules, except at an Annual General Meeting, or a special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership.

Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(On my personal knowledge.)

This Certificate was read 18

The Ballot will take place 18

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

At University College, Gower Street, W.C.,

ON THE

SECOND AND FOURTH FRIDAYS OF EVERY MONTH.

1888.—Friday,	January	...	...	13	...	27
,,	February	...	...	10	...	24*
,,	March	...	...	9	...	23
,,	April	...	...	13	...	27
,,	May ...	...	...	11	...	25
,,	June...	...	...	8	...	22
,,	July ...	...	...	13	...	27
,,	August	...	...	10	...	24
,,	September ...		...	14	...	28
,,	October	...	...	12	...	26
,,	November ...		...	9	...	23
,,	December	...	...	14	...	28
1889. ,,	January	...	...	11	...	25
,,	February	...	...	8	...	22*

The Meetings on the *second* Friday of each month, and on July 27th and August 24th, are for conversation and exhibition of objects, from 7 to 9.30 p.m.

* The Annual General Meeting will be held on the fourth Friday in February, at 8 o'clock, for Election of Officers and other Business.

EXCURSIONS, 1888.

April 7. ROYAL BOTANIC GARDENS, REGENT'S PARK. To meet at the Entrance at 3 p.m.

April 21. SNARESBROOK. Returning from George Lane Station. To meet at Liverpool Street Station.

May 5. HAYES for KESTON. To meet at Cannon Street Station.

May 26. STAINES. To meet at Waterloo, Loop Line Station.

June 9. WOOD STREET for EPPING FOREST. To meet at Liverpool Street Station.

June 23. PLUMSTEAD. To meet at Cannon Street Station.

July 7. DAY EXCURSION, WHITSTABLE. To meet at Holborn Viaduct Station, 10 a.m., or next later train. (Unless at least fifteen members notify their intention of going on this Excursion a reduction of fares cannot be obtained, and notice should be given to the Secretary of the Excursions Sub-Committee on or before June 30.)

July 21. SHEPPERTON for WALTON. To meet at Waterloo, Loop Line Station.

Sept. 1. WOKING. To meet at Waterloo, Main Line Station.

Sept. 15. BARNES for RICHMOND PARK. Returning from Kingston. To meet at Waterloo, Loop Line Station.

Sept. 29. WOODSIDE PARK, for TOTTERIDGE. Returning by Mill Hill. To meet at Broad Street Station.

Oct. 13. HAMPTON COURT. To meet at Waterloo Suburban Station.

The time for departure from town, unless otherwise specified, will be THE FIRST TRAIN AFTER TWO O'CLOCK.

Ed. Dadswell,	J. T. Powell,	Excursions Sub-Committee.
J. D. Hardy,	C. Rousselet,	
F. W. Hembry,	Jas. Spencer,	

Fredk. A. Parsons, Hon. Sec. Excursions Sub-Committee,
3, Osborne Road, Finsbury Park, N.

TREASURER'S STATEMENT OF ACCOUNTS, 1888.

Dr.

	£	s.	d.
Balance to Christmas last	149	8	11
Subscriptions since received	196	5	0
Dividends on Moneys Invested	4	6	1
Sale of Journal	4	10	0
	£354	10	0

Cr.

	£	s.	d.
By Postage and Carriage	5	9	5
Printing and Stationery	10	11	0
Attendance, Lighting, and College Expenses ...	21	7	6
Petty Expenses	2	2	8
Property Purchased	28	5	3
Journal Expenses	104	3	9
Special Exhibition	7	14	0
Balance in hand	174	16	5
	£354	10	0

Moneys invested in £2 15s. Per Cent. Consols, £140.

We, the undersigned, having examined the above statement of Income and Expenses, and the Vouchers relating thereto, hereby certify the same to be correct.

WM. HAINWORTH,
F. H. P. HIND, } Auditors.

OFFICERS AND COMMITTEE.

(Elected February, 1889.)

President.

Prof. B. T. Lowne, F.R.C.S., F.L.S., &c.

Vice-Presidents.

A. D. Michael, F.L.S., F.R.M.S., &c.
Prof. C. Stewart, M.R.C.S., F.L.S., F.R.M.S., &c.
E. T. Newton, F.G.S., &c.
E. M. Nelson.

Committee.

F. A. Parsons, F.R.M.S.
J. J. Vezey, F.R.M.S.
H. J. Waddington.
T. C. White, M.R.C.S., L.D.S., F.R.M.S.
B. W. Priest.
J. G. Waller, F.S.A.
F. W. Hembry, F.R.M.S.
J. Spencer, F.R.M.S.
H. Morland.
E. Dadswell, F.R.M.S.
W. W. Reeves, F.R.M.S.
C. Rousselet, F.R.M.S.

Hon. Treasurer.

F. W. Gay, F.R.M.S., 113, High Holborn, W.C.

Hon. Secretary.

G. C. Karop, M.R.C.S., F.R.M.S., 198, Holland Road, Kensington, W.

Hon. Sec. for Foreign Correspondence and Editor of Journal.

Henry F. Hailes, 15, Westfield Road, Hornsey, N.

Hon. Reporter.

R. T. Lewis, F.R.M.S.

Hon. Librarian.

Alpheus Smith,
8, Hanover Park, Peckham, S E.

Hon. Curator.

Charles Emery,
10, New Road, Crouch End, N.

PAST PRESIDENTS.

	Elected.	
EDWIN LANKESTER, M.D., F.R.S. - -	July,	1865.
ERNEST HART - - - - - -	„	1866.
ARTHUR E. DURHAM, F.R.C.S., F.L.S., &c.	„	1867.
„ „ „ „ - -	„	1868.
PETER LE NEVE FOSTER, M.A. - -	„	1869.
LIONEL S. BEALE, M.B., F.R.S., &c. - -	„	1870.
„ „ „ „ - -	„	1871.
ROBERT BRAITHWAITE, M.D., F.L.S., &c.	„	1872.
„ „ „ „ - -	„	1873.
JOHN MATTHEWS, M.D., F.R.M.S. - -	„	1874.
„ „ „ „ - -	„	1875.
HENRY LEE, F.L.S., F.G.S., F.R.M.S., F.Z.S.	„	1876.
„ „ „ „ - -	„	1877.
THOS. H. HUXLEY, LL.D., F.R.S., &c. - -	„	1878.
T. SPENCER COBBOLD, M.D., F.R.S., F.L.S., &c.		1879.
T. CHARTERS WHITE, M.R.C.S., F.L.S., &c.	„	1880.
„ „ „ „ - -	„	1881.
M. C. COOKE, M.A., LL.D., A.L.S. „ - -	„	1882.
„ „ „ „ - -	„	1883.
W. B. CARPENTER, C.B., F.R.S., &c., &c. -	„	1884.
A. D. MICHAEL, F.L.S., F.R.M.S., &c. - -	„	1885.
„ „ „ „ - -	Feb.	1887.
B. T. LOWNE, F.R.C.S., F.L.S., &c. - - -	„	1888.

HONORARY MEMBERS.

Date of Election.	
Jan. 24, 1868.	Arthur Mead Edwards, M.D., 120, Belleville avenue, Newark, New Jersey, U.S.A.
Mar. 19, 1869.	The Rev. E. C. Bolles, Salem, Mass., U.S.A.
July 26, 1872.	Professor Hamilton L. Smith, Hon. F.R.M.S., President of Hobart College, Geneva, New York, U.S.A.
July 23, 1875.	Lionel S. Beale, M.B., F.R.S., F.R.M.S., &c. (*Past President*), 61, Grosvenor street, W.
Sept. 22, 1876.	Frederick Kitton, Hon. F.R.M.S., &c., 8, West Kensington terrace, W.
July 25, 1879.	Dr. E. Abbé, Hon. F.R.M.S., University, Jena, Saxe Weimar, Germany.
July 23, 1880.	F. H. Wenham, C.E., 112, New Bond street, W.
Nov. 24, 1882.	Dr. Veit B. Wittrock, Professor at the Royal Academy of Sciences, and Director of the Museum of Natural History, Stockholm, Sweden.

LIST OF MEMBERS.

Date of Election.	
Oct. 26, 1883.	Addiscott, C. J., Sydney villa, St. Bildas road, Manor park, Stoke Newington, N.
Nov. 23, 1888.	Alabaster, J. H., The Hollies, King's road, Richmond, Surrey.
Oct. 24, 1884.	Allen, W. A., 156, Choumert road, Rye lane, Peckham, S.E.
Dec. 17, 1869.	Ames, G. A., F.R.M.S., Union Club, Trafalgar square, W.C.
Dec. 22, 1865.	Andrew, F. W., 3, Neville terrace, Onslow gardens, S.W.
June 22, 1883.	Ash, George C., 141, Maida vale, W.
Feb. 22, 1889.	Ashe, A., Roman villa, Laurie square, Romford, Essex.
July 25, 1879.	Ashbridge, Arthur, 76, Leadenhall street, E.C.
Dec. 28, 1883.	Bailey, Rev. G., F.R.M.S., The Manse, Finchingfield, Essex.
Dec. 27, 1867.	Bailey, J. W., 75, Broke road, Dalston, E.
April 24, 1868.	Baker, Charles, F.R.M.S., 244, High Holborn, W.C.
Nov. 23, 1888.	Banham, E.E., High street, Ealing, W.
Jan. 24, 1879.	Barham, G. T., Danehurst, Hampstead, N.W.
Dec. 27, 1872.	Barnard, Herbert, 33, Portland place, W.
April 22, 1870.	Barnes, C. B., 4, Egremont villas, White Horse lane, South Norwood, S.E., and 27, Clement's lane, E.C.
July 27, 1883.	Barnes, Henry, Patschull house, Dartmouth Park avenue, N.
Dec. 23, 1887.	Barnes, W., 39, Frederick street, Gray's Inn road, W.C.
May 25, 1883.	Barratt, Thomas, Bell Moor house, Upper Heath, Hampstead, N.W.

Date of Election.	
Sept. 27, 1872.	Bartlett, Edward, L.D.S., M.R.C.S.E., 38, Connaught square, W.
Nov. 26, 1875.	Beaulah, John, Raventhorpe, Brigg.
July 25, 1884.	Beck, C., F.R.M.S., 68, Cornhill, E.C.
May 26, 1871.	Bedwell, Judge, M.A.Cantab., West parade, Hull, Yorkshire.
Mar. 23, 1888.	Beet, Rev. J. A., Wesleyan Theological Institute, Richmond, Surrey.
Mar. 28, 1884.	Beetham, A., 14, South square, Gray's Inn, W.C.
June 25, 1886.	Bernau, F. G., "Brabant," Tulse hill, S.W.
May 22, 1868.	Berney, John, F.R.M.S., 61, North end, Croydon.
Oct. 23, 1868.	Bevington, W. A., F.R.M.S., "Avondale," Coloraine road, Blackheath, S.E.
July 23, 1886.	Bickerton, G. A., St. George's lodge, Queen's road, Richmond, Surrey.
Feb. 23, 1866.	Blake, T., 41, Finsbury Circus, E.C.
July 27, 1877.	Blenkinsop, B., Shord hill, Kenley, Surrey.
May 26, 1876.	Blundell, J., Stock Exchange, E.C.
Feb. 24, 1888.	Boldon, G. J., 75, Oxford road, Gunnersbury.
Dec. 27, 1881.	Bolton, J. G. E., M.R.C.S., Savanne, Mauritius.
Nov. 23, 1883.	Bostock, E., F.R.M.S., "The Radfords," Stone, Staffordshire.
Jan. 23, 1885.	Bousfield, E. C., L.R.C.P.Lond., M.R.C.S., 363, Old Kent road, S.E.
Oct. 27, 1865.	Braithwaite, Robert, M.D., M.R.C.S.E., F.L.S., F.R.M.S. (*Past President*), The Ferns, 303, Clapham road, S.W.
May 26, 1876.	Brigstock, J. W., "Ferntower," Manor road, Stoke Newington, N.
Mar. 25, 1887.	Broad, C. S., The Chestnuts, Harlesden, N.W.
Oct. 27, 1883.	Brown, Fredk. Wm., 35, Walterton road, St. Peter's park, Harrow road, W.
May 22, 1868.	Brown, W. J., 17, Maple road, Anerley, S.E.
Jan. 28, 1887.	Browne, E. T., F.R.M.S., Uxbridge lodge, Uxbridge road, Shepherd's Bush, W.
May 26, 1871.	Browne, George, 45, Victoria road, Kentish Town, N.W.
May 28, 1875.	Browne, J. W., Frascati, Masons hill, Bromley, Kent.

Date of Election.	
Jan. 23, 1880.	Browne, W. R., Alder cottage, Isleworth.
June 25, 1886.	Bryant, E., Harold Wood Hall, Harold Wood, Essex.
May 22, 1885.	Buckland, H.
Dec. 22, 1882.	Bucknall, Edward, 16, Junction road, Highgate, N.
Jan. 26, 1877.	Buffham, T. H., Hughenden villa, Comley Bank road, Walthamstow.
June 22, 1883.	Burbidge, William Henry, Marlyns house, Guildford, Surrey.
Aug. 22, 1879.	Burton, William, 27, Wigmore street, W.
June 14, 1865.	Bywater, W. M., F.R.M.S., 5, Hanover square, W.
June 25, 1880.	Cambridge, John, Bury St. Edmunds, Suffolk.
May 23, 1879.	Carpenter, H. S., F.R.M.S., Beckington house, Weighton road, Anerley, S.E.
July 23, 1880.	Carr, Ebenezer, 26, Bromar road, Denmark park, S.E.
May 26, 1882.	Chapman, W. Ingram, F.R.M.S., 5, Hollywood villas, Melrose road, Southfields, S.W.
Dec. 27, 1878.	Chatto, Andrew, 214, Piccadilly, W.
Mar. 22, 1878.	Chester, The Dean of, The Deanery, Chester.
Nov. 27, 1874.	Chippendale, George, 4, Marco road, The Grove, Hammersmith, W.
Dec. 27, 1881.	Claremont, Claude Clarke, M.R.C.S., Millbrooke house, Hampstead road, N.W.
Feb. 23, 1883.	Clark, Joseph, F.R.M.S., Hind Hayes, Street, Somerset.
May 22, 1885.	Clinch, J. W., Lake Brewery, Douglas, Isle of Man.
Mar. 23, 1888.	Cockram, P., 74, Fortess road, Kentish Town, N.W.
May 22, 1868.	Cocks, W. G., 36, Gayhurst road, Dalston, E.
Jan. 25, 1867.	Coles, Ferdinand, F.L.S., F.R.M.S., 53, Brooke road, Stoke Newington common, N.
June 22, 1888.	Collins, Rev. C. C., M.A., Teddington.
June 14, 1865.	Cooke, M. C., M.A., LL.D., A.L.S. (*Past President*), 146, Junction road, Upper Holloway, N.

Date of Election.	
Feb. 22, 1867.	Cooper, F. W., L.R.C.S.Edin., Leytonstone, E.
June 27, 1873.	Corbett, A. L., 11, Orlando road, Clapham, S.W.
May 28, 1869.	Cottam, Arthur, F.R.A.S., H.M.Office of Woods, Whitehall place, S.W.
Jan. 22, 1886.	Coventon, C. A., Morwenstow, West Enfield.
July 26, 1872.	Cowan, T. W., F.E.S., F.R.M.S., Avenue de la Gare, Lausanne, Switzerland.
July 22, 1887.	Cowling, R. G., 47, Dockley road, Bermondsey, S.E.
Aug. 28, 1868.	Crisp, Frank, LL.B., B.A., *V.P. and Treas. Linnean Society; Sec. Royal Microscopical Society*, 5, Lansdowne road, Notting hill, W.
Dec. 23, 1870.	Crisp, J. S., F.R.M.S., Ashville, Lewin road, Streatham, S.W.
July 26, 1878.	Crockford, Wm., 2, St. Peter's road, Mile end, E.
Feb. 23, 1877.	Crofton, Edward, M.A.(Oxon.), F.R.M.S., 45, West Cromwell road, South Kensington, S.W.
June 25, 1886.	Crookshank, Prof. E. M., M.B., F.R.M.S., 24, Manchester square, W.
Sept. 26, 1884.	Crowhurst, H. A., 313, High Holborn, W.C.
June 25, 1880.	Curties, C. Lees, 244, High Holborn, W.C.
May 25, 1866.	Curties, Thomas, F.R.M.S., 244, High Holborn, W.C.
June 25, 1880.	Curties, W. Irvin, 244, High Holborn, W.C.
Sept. 26, 1879.	Curtis, Charles, 29, Baker street, Portman sq., W.
April 22, 1881.	Cutting, W. M., 1, Curtain road, E.C.
Aug. 27, 1886.	Daddo, W. S., M.A., 59, Southborough road, South Hackney, E.
Jan. 22, 1875.	Dadswell, E., F.R.M.S., 21, Montrell road, Streatham hill, S.W.
Nov. 23, 1877.	Dallas, W. S., F.L.S., &c., the Geological Society, Burlington house, Piccadilly, W.
Feb. 23, 1883.	Dallinger, Rev. W. H., LL.D., F.R.S., F.R.M.S., Ingleside, Newstead road, Lee, S.E.
May 23, 1879.	Dallmeyer, T. R., 25, Newman street, Oxford street, W.
May 22, 1878.	Darke, Edward, 16, Rochester terrace, Camden road, N.W.

Date of Election.

Nov. 23, 1888.	Davies, H. R., 139, Richmond road, Hackney, E.
May 23, 1879.	Dawson, W., F.R.M.S., 24, Abbeygate street, Bury St. Edmunds, Suffolk.
May 28, 1875.	Dean, Arthur (*Hon. Sec. East Lond. Mic. Soc.*), 57, Southborough road, South Hackney, E.
Feb. 28, 1879.	Debenham, E. H., 9, Mincing lane, E.C.
Jan. 24, 1879.	Deby, Julien, C.E., F.R.M.S., 31, Belsize avenue, St. John's Wood, N.W.
Nov. 24, 1876.	Despointes, Francis, 16, St. George's square, Regent's park road, N.W.
May 25, 1883.	Drake, C. A., The Distillery, Three Mill lane, Bromley-by-Bow.
Oct. 25, 1872.	Dunning, C. G., 55, Camden park road, N.W.
Sept. 22, 1865.	Durham, A. E., F.R.C.S., F.L.S., F.R.M.S., &c. (*Past President*), 82, Brook street, Grosvenor square, W.
July 27, 1883.	Durrand, Alexander, F.R.M.S.
Sept. 25, 1868.	Eddy, J. R., F.R.M.S., F.G.S., The Grange, Carleton, Skipton, Yorkshire.
May 26, 1876.	Emery, Charles (*Hon. Curator*), 10, New road, Crouch end, N.
Feb. 28, 1879.	Epps, Hahnemann, F.R.M.S., 95, Upper Tulse hill, Brixton, S.W.
Feb. 21, 1884.	Epps, J., jun., "The Homestead," Ross road, South Norwood hill, S.E.
July 25, 1873.	Fase, Rev. H. J., 8, Dents road, Wandsworth common, S.W.
June 25, 1875.	Faulkner, Henry, jun., Fernwood, Roehampton park, S.W.
Jan. 28, 1876.	Faulkner, John, 20, Mornington crescent, N.W.
Aug. 25, 1882.	Field, W. H., 39, Crouch Hall road, Crouch end, N.
Feb. 27, 1880.	Fieldwick, Alfred, jun., 284, Dalston lane, Hackney, E.
July 22, 1881.	Firth, W. A., 95, City View terrace, Falls road, Belfast.
July 26, 1867.	Fitch, Frederick, F.R.G.S., F.R.M.S., Hadleigh house, Highbury New park, N.

Date of Election.	
Feb. 24, 1882.	Fitch, J. N., 17, Eversholt street, Camden Town, N.W.
Feb. 24, 1888.	Fletcher, W. W., 24, Woodsome road, Highgate road, N.W.
Nov. 23, 1888.	Flood, W. C., 55, Aubert park, Highbury, N.
Nov. 28, 1879.	Forster, William, jun., Cleveland road, Woodford, Essex.
Mar. 24, 1871.	Foulerton, John, M.D., 44, Pembridge villas, Bayswater, W.
Oct. 24, 1884.	Fowler, C., Estelle road, Mansfield road, Gospel Oak, N.W.
Dec. 28, 1866.	Fox, C. J., 65, Faubourg Poissonnière, Paris.
June 23, 1871.	Freeman, H. E., 104, Shaftesbury road, Crouch hill, N.
May 22, 1868.	Fryer, G. H., Westhaven, Cricklewood, N.W.
July 23, 1880.	Funston, James, 93, Finsbury pavement, E.C.
Mar. 25, 1870.	Garden, R. S., 42, Carlton hill, St. John's wood, N.W.
July 7, 1865.	Gay, F. W., F.R.M.S. (*Hon. Treasurer*), 113, High Holborn, W.C.
July 26, 1867.	George, Edward, F.R.M.S., Vernon house, Westward park, Forest hill, S.E.
Feb. 24, 1888.	Gill, G. J., Miskin road, Dartford, Kent.
Nov. 28, 1879.	Goodinge, A. C., 119, High Holborn, W.C.
April 26, 1872.	Goodinge, J. W., F.R.G.S., F.R.M.S., 119, High Holborn, W.C.
Nov. 23, 1877.	Goodwin, William, 19, Prospero road, Upper Holloway, N.
July 27, 1883.	Goold, Ernest H., C.E., F.Z.S., M.R.I., 4, Dane's Inn, Strand, W.C.
Dec. 23, 1887.	Goslett, F., 20, Fisherton street, Salisbury.
Mar. 27, 1866.	Gray, S. O., Bank of England, E.C.
Oct. 23, 1868.	Greenish, Thomas, F.R.M.S., 20, New street, Dorset square, N.W.
Feb. 25, 1887.	Gross, W., 23, York place, Portman square, W.
Jan. 28, 1887.	Grove, E., F.R M.S., Seabank, West Worthing, Sussex.
July 24, 1868.	Groves, Prof. J. W., F.R.M.S., 90, Holland road, Kensington, W.

Date of Election.	
July 24, 1868.	Grubbe, E. W., C.E., 5, Chepstow place, Bayswater, W.
Jan. 27, 1871.	Guimaraens, A. de Souza, F.R.M.S., 52, Lowden road, Herne hill, S.E.
Sept. 28, 1877.	Hagger, John, Repton school, Burton-on-Trent.
Feb. 25, 1881.	Haigh, William, Tempsford villa, Uxbridge road, Ealing, W.
June 14, 1865.	Hailes, H. F. (*Hon. Secretary for Foreign Correspondence and Editor*), 15, Westfield road, Hornsey, N.
Feb. 23, 1867.	Hainworth, William, 9, Oakfield road, Clapton, E.
Sept. 28, 1888.	Hall, T. F., 29, Kensington court, W.
Dec. 28, 1866.	Hallett, R. J., 163, Seymour street, Euston square, N.W.
Feb. 22, 1869.	Hammond, A., F.L.S., 30, Versailles road, Anerley, S.E.
Oct. 22, 1886.	Hampton, W., 38, Lichfield street, Hanley, Staffordshire.
June 25, 1880.	Hancock, H. S. H., 50, Springdale road, Stoke Newington, N.
Feb. 24, 1882.	Harding, J. H., 4, Finsbury square, E.C.
July 25, 1879.	Hardingham, G. G., F.R.M.S., F.R.B.S., Carrownaffe, Albany road, Southsea, Hants.
Jan. 23, 1874.	Hardy, J. D., F.R.M.S., 73, Clarence road, Clapham, E., and 4, Lombard street, E.C.
Sept. 28, 1866.	Harkness, W., F.R.M.S., Laboratory, Somerset house, W.C.
Nov. 27, 1885.	Harris, F. W., Hilltop villa, Shootup hill road, Cricklewood, N.W.
April 23, 1875.	Harrison, James, 150, Akerman road, North Brixton, S.W.
May 23, 1884.	Havers, J. C., F.R.M.S., Joyce Grove, Nettlebed, Henley-on-Thames.
Mar. 28, 1879.	Hawkins, C. E., H.M. Geological Survey, Jermyn street, S.W.
June 28, 1867.	Hawksley, T. P., 97, Adelaide road, N.W.
June 22, 1883.	Hazlewood, Jas. Edmund, F.R.M.S., 3, Lennox place, Brighton.

Date of Election.	
Aug. 23, 1872.	Hembry, F. W., F.R.M.S., Sussex Lodge, Sidcup, Kent.
June 26, 1868.	Henry, A. H., 73, Redcliffe gardens, S.W.
Feb. 26, 1886.	Hewlett, R. T., Sandhill house, King's farm, Richmond, Surrey.
April 25, 1884.	Higgins, J., London University, Burlington gardens, W.
Sept. 24, 1869.	Hilton, T. D., M.D., Upper Deal, Kent.
Sept. 28, 1866.	Hind, F. H. P., 11, Copthall court, Throgmorton street, E.C.
May 22, 1874.	Hind, George, 244, High Holborn, W.C.
Feb. 26, 1875.	Holford, Christopher, Bounty Office, Dean's yard, Westminster, S.W.
Jan. 23, 1880.	Holland, C. F., Royal Exchange Assurance, Royal Exchange, E.C.
Nov. 26, 1880.	Hopkins, Robert, Shearn villa, Walthamstow, Essex.
Oct. 26, 1866.	Horncastle, Henry, Cobham, near Woking station.
May 22, 1874.	Hovenden, C. W., F.R.M.S., 95, City road, E.C.
April 26, 1867.	Hovenden, Frederick, F.R.M.S., Glenlea, Thurlow park road, Dulwich, S.E.
Jan. 27, 1888.	How, W. S., 75, Great Portland street, W.
Oct. 27, 1876.	Howard, D., 60, Belsize park, N.W.
Oct. 25, 1878.	Howling, W. E., Crowley's Brewery, Alton, Hants.
Sept. 23, 1887.	Hughes, F. T., 48, Malvern road, Kilburn, N.W.
May 28, 1886.	Hughes, W., 32, Heathland road, Stoke Newington, N.
July 25, 1873.	Hurst, J. T., 1, Raymond villas, Geraldine road, Wandsworth, S.W.
June 28, 1878.	Huxley, Prof. T. H., F.R.S., &c. (*Past President*), Science Schools, South Kensington, S.W.
May 24, 1867.	Ingpen, J. E., F.R.M.S, 7, The Hill, Putney, S.W.
Dec. 17, 1875.	Jackson, C. L., F.L.S., F.Z.S., F.R.M.S, Hill Fold, Sharples, Bolton.
July 24, 1868.	Jackson, F. R., Culver cottage, Slindon, Arundel, Sussex.

Date of Election.	
June 25, 1880.	Jacques, Walter, 2, Fenchurch buildings, E.C.
Aug. 25, 1882.	Jakeman, Christopher, 72, South street, Greenwich.
Feb. 27, 1885.	Jaques, E. K., 36, Old Gravel lane, St. George's, E.
June 14, 1865.	Jaques, Edward, B.A., H.M. Office of Woods, Whitehall place, S.W.
Nov. 23, 1888.	Jefferys, T. G., 11, Edith road, St. Mary's road, Peckham, S.E.
Oct. 26, 1888.	Jenkins, A. J., 6, Douglas terrace, Douglas street, Deptford, S.E.
Feb. 21, 1884.	Jennings, A. V., 8, Broadhurst gardens, South Hampstead, N.W.
July 24, 1868.	Jennings, Rev. Nathaniel, M.A., F.R.A.S., 8, Broadhurst gardens, South Hampstead, N.W.
Feb. 24, 1871.	Johnson, M. Hawkins, F.G.S., 379, Euston road, N.W.
Mar. 24, 1871.	Johnstone, James, Y Coed, Stroud, Gloucestershire.
Feb. 28, 1873.	Jones, G. J., Wheelgate, Malton, Yorks.
May 23, 1873.	Karop, G. C., M.R.C.S., F.R.M.S., &c. (*Hon. Secretary*), 198, Holland road, Kensington, W.
July 25, 1884.	Kern, J. J., Fern Glen, Selhurst park, South Norwood, S.E.
Mar. 19, 1869.	Kilsby, T. W., 4, Brompton villas, Edmonton.
April 22, 1881.	King, H. W., The Cedars, Upper Park road, New Southgate, N.
Feb. 28, 1873.	Kitsell, F. J., 24, St. Stephen's avenue, Goldhawk road, Shepherd's Bush, W.
Jan. 24, 1879.	Lancaster, A. H., 5, Campden hill gardens, Kensington, W.
Mar. 22, 1867.	Lancaster, Thomas, Bownham house, Stroud, Gloucestershire.
Feb. 24, 1888.	La Thangue, R., 60, Colverstone crescent, Hackney, E.
June 25, 1869.	Layton, C. E., 12, Upper Hornsey rise, N.
Aug. 28, 1868.	Leaf, C. J., F.L.S., F.R.M.S., &c. (*President of the Old Change Microscopical Society*), 6, Sussex place, Regent's park, N.W.

Date of Election.	
Nov. 25, 1887.	Lewer, J. J., 20, Crossfield road, Belsize, N.W.
April 27, 1866.	Lewis, R. T., F.R.M.S. (*Hon. Reporter*), 28, Mount Park crescent, Ealing, W.
June 26, 1868.	Lindley, W. H., jun., 29, Blittersdorffs platz, Frankfort-on-Maine.
Nov. 27, 1885.	Lloyd, F. G., Westleigh, Watford, Herts.
May 26, 1871.	Locke, John, 16, Georgiana street, Camden Town, N.W.
Nov. 24, 1866.	Lovibond, J. W., F.R.M.S., St. Anne street, Salisbury.
Sept. 22, 1866.	Lovick, T., 53, Queen's crescent, Haverstock hill, N.W.
Sept. 23, 1887.	LOWNE, B. T., F.R.C.S., F.L.S., &c. (*President*), 65, Cambridge gardens, Notting hill, W.
Jan. 22, 1886.	Lyons, A. W., 25, Bessborough gardens, S.W.
Nov. 23, 1866.	McIntire, S. J., F.R.M.S., 14, Hetley road, Uxbridge road, Shepherd's Bush, W.
Jan. 23, 1880.	Mackenzie, James, Warden villa, Uxbridge road, Ealing, W.
Jan. 24, 1884.	Macrae, A. C., M.D., 119, Westbourne terrace, Hyde park, W.
May 25, 1883.	Mainland, G. E., F.R.M.S., Glenthorp, Woodside lane, North Finchley, N.
May 25, 1883.	Mais, H. T. Coathorpe, M.I.C.E., Engineer in Chief, Adelaide, South Australia (care of T. Curties, 244, High Holborn, W.C.).
Sept. 27, 1872.	Manning, His E. the Cardinal Archbishop, Archbishop's house, Westminster, S.W.
April 26, 1867.	Matthews, G. K., St. John's lodge, Beckenham, Kent.
May 26, 1871.	May, J. W., F.R.M.S., Arundel house, Percy-cross, Fulham, S.W.
Feb. 25, 1876.	May, W. R., 109, Queen's road, Dalston, E.
Feb. 28, 1879.	Menzies, James, 149, Brecknock road, N.W.
May 22, 1874.	Messenger, G. A., Lloyds, E.C.
July 27, 1877.	MICHAEL, A. D., F.L.S., F.R.M.S. (*Vice-President*), Cadogan Mansions, Sloane square, Chelsea, S.W.
July 7, 1865.	Millett, F. W., F.R.M.S., Marazion, Cornwall.

Date of Election.	
Sept. 22, 1882.	Moore, George, 7, Draper's gardens, Throgmorton street, E.C.
July 26, 1878.	Morland, Henry, Cranford, near Hounslow.
Jan. 24, 1879.	Murray, James, Osborne house, 271, Goldhawk road, Shepherd's Bush, W.
Feb. 22, 1878.	Needham, S. H., F.R.G.S., F.G.S., 33, Somerfield road, Finsbury park, N.
Mar. 24, 1876.	Nelson, E. M. (*Vice-President*), Cleve house, West End lane, West Hampstead, N.W.
Nov. 25, 1881.	Nevins, R. T. G., F.R.M.S., Pembroke lodge, Hildenborough, Tonbridge.
Jan. 26, 1872.	Newton, E. T., F.G.S. (*Vice-President*), Geological Museum, Jermyn street, S.W.
Feb. 27, 1880.	Niven, George, Erkingholme, Coolhurst road, Crouch end, N.
May 22, 1874.	Nixon, P. C., F.R.M.S., Oporto, Portugal.
Dec. 28, 1888.	Oakden, C. H., 51, Melbourne grove, East Dulwich, S.E.
Jan. 24, 1879.	Offord, J. M., F.R.M.S., 15, Loudoun road, St. John's Wood, N.W.
Dec. 22, 1876.	Ogilvy, C. P., F.L.S., Sizewell house, Leiston, near Saxmundham, Suffolk.
May 24, 1878.	O'Hara, Lt.-Col. Richard, F.R.M.S. (late Royal Artillery), West lodge, Galway.
Dec. 28, 1883.	Oliver, J., 123, Stamford street, S.E.
June 23, 1882.	Ollard, John Alex., F.R M.S., 38, Gracechurch street, E.C.
Dec. 27, 1867.	Oxley, Frederick, F.R.M.S., 8, Crosby square, Bishopsgate street, E.C.
July 24, 1885.	Parker, J. A. D., Sunny hill, Camden park, Chislehurst.
Mar. 27, 1885.	Parritt, H. W., 103, Camden street, Camden Town, N.W.
Oct. 27, 1871.	Parsons, F. A., F.R.M.S., 90, Leadenhall street, E.C.; and 15, Osborn road, Finsbury park, N.
Feb. 25, 1887.	Patterson, G., 85, Carlton road, Tufnell park, N.

Date of Election.	
July 23, 1886.	Paul, R., Broadway, Ealing, W.
April 23, 1875.	Peal, C. N., F.R.M.S., Fernhurst, Mattock lane, Ealing, W.
July 22, 1887.	Pearce, G., Brabourne Haigh, Highwood hill, N.W.
May 24, 1867.	Pearson, John, 3, Westbourne Grove, W.
July 22, 1881.	Perigal, Henry, F.R.A.S., F.R.M.S., 9, North crescent, Bedford square, W.C.
May 28, 1886.	Peterborough, the Bishop of, The Palace, Peterborough.
Dec. 23, 1887.	Pigott, G. W. Royston, M.A., M.D., F.R.S., Annandale, Eastbourne, Sussex.
May 23, 1879.	Pilcher, W. J., F.R.C.S., etc., Boston, Lincolnshire.
Sept. 27, 1878.	Plomer, G. D., F.R.M.S., 48, Springfield road, St. John's Wood, N.W.
Nov. 23, 1883.	Plowman, T., jun., Nystuen lodge, Bycullah park, Enfield.
Sept. 28, 1877.	Pocklington, Henry, F.R.M.S., 20, Park road, Leeds.
July 24, 1885.	Porter, J. L. M., 8, Wood vale, Forest hill, S.E.
Nov. 23, 1866.	Potter, George, F.R.M.S., 66, Grove road, Holloway, N.
Jan. 25, 1878.	Potts, R. A., 26, South Audley street, W.
June 24, 1881.	Potts, William, Winchester house, Old Broad street, E.C.
June 22, 1866.	Powe, I., 76, St. George's street, Richmond, Surrey.
April 25, 1879.	Powell, H. P., Mill Platt, Isleworth.
May 26, 1876.	Powell, J. T., 32, Dunlace road, Lower Clapton, E.
July 7, 1865.	Powell, Thomas H., F.R.M.S., 18, Doughty street, Mecklenburg square, W.C.
June 27, 1873.	Priest, B. W., 22, Parliament street, S.W.
April 27, 1888.	Pringle, A., F.R.M.S., Cromwell House, Bexley Heath, S.E.
May 23, 1879.	Pritchard, J. D., Crymlyn Burrows, near Swansea.
Feb. 25, 1881.	Probyn, Clifford, 55, Grosvenor street, W.
April 23, 1868.	Quekett, A. E., 51, Warwick road, Maida hill, W.

Date of Election.

April 23, 1868.	Quekett, A. J. S., 51, Warwick road, Maida hill, W.
Oct. 26, 1866.	Rabbits, W. T., Irongates, Dacres road, Forest hill, S.E.
June 25, 1875.	Radford, W. S., M.D., F.R.M.S., Sidmouth.
Oct. 26, 1866.	Ramsden, Hildebrand, M.A. (Cantab.), F.L.S., F.R.M.S., 26, Upper Bedford place, Russell square, W.C.
Aug. 28, 1868.	Rance, T. G., Elmside, Bickley, Kent.
June 24, 1881.	Ransom, F., Fairfield, Hitchin.
Dec. 27, 1878.	Reed, J. M., Sidmouth house, South park, Ilford, E.
June 22, 1877.	Reed, J. W., F.R.G.S., 17, Colebrooke road, Islington, N.
June 27, 1873.	Reeve, Frederick, 113, Clapham road, S.W.
July 7, 1865.	Reeves, W. W., F.R.M.S., 32, Geneva road, Brixton, S.W.
Oct. 28, 1881.	Reynolds, W. P., 74, King William street, E.C.
Mar. 25, 1887.	Robinson, I., Hertford.
May 22, 1868.	Rogers John, F.R.M.S., 4, Tennyson street, Nottingham.
May 22, 1868.	Roper, Freeman, C.S., F.L.S., F.R.M.S., F.G.S., Palgrave house, Eastbourne, Sussex.
June 23, 1876.	Roper, H. J., F.R.M.S., 7, Carlton grove, Peckham, S.E.
Jan. 24, 1884.	Rosseter, T. B., F.R.M.S., Fleur de Lis, Canterbury.
Jan. 26, 1883.	Rousselet, Charles, F.R.M.S., 308, Regent street, W.
July 24, 1868.	Rowe, J., jun., M.R.C.V.S., 65, High street, Marylebone, W.
April 27, 1888.	Russell, J., 1, Deemount terrace, Aberdeen.
April 24, 1885.	Russell, A. H., 10, Cleveland gardens, W.
Oct. 27, 1865.	Russell, James, 10, High street, Shoreditch, E.
May 22, 1868.	Russell, T. D., Coningsby villas, Rosendale road, West Dulwich, S.E.
Feb. 22, 1867.	Rutter, H. L., 24, Crownhurst road, Angel road, Brixton, S.W.

Date of Election.	
Nov. 22, 1878.	Sabel, E. E., 6, Grove road, Clapham park, S.W.
Dec. 17, 1869.	Salmon, John, 24, Seymour street, Euston square, N.W.
June 27, 1879.	Sawyer, G. D., F.R.M.S., 55, Buckingham place, Brighton.
Feb, 27, 1880.	Schulze, Adolf, F.R.M.S., 2, Doune gardens, Kelvinside, Glasgow, N.B.
Mar. 24, 1882.	Selby, H., 94, Wharton road, West Kensington park, W.
Mar. 26, 1886.	Sercombe, H., 67, Lombard street, E.C.
July 27, 1868.	Sewell, R., Ashmore, King's road, Clapham park, S.W.
July 23, 1880.	Shaw, H. V., Fir Croft, Keymer, Hurstpierpoint, Sussex.
Oct. 22, 1869.	Shaw, W. F. Mosshall grove, Finchley, N.
May 26, 1876.	Shepheard, Thomas, F.R.M.S., Kingsley lodge, Chester.
May 26, 1871.	Sigsworth, J. C., F.R.M.S., 54, Portland road, Notting hill, W.
Mar. 23, 1888.	Simmonds, H. M., M.R.C.S., 66, Camberwell road, S.E.
Aug. 23, 1867.	Simmons, J. J., L.D.S., 18, Burton crescent, Euston road, N.W.
Oct. 28, 1881.	Simons, W. V., Nilgiri house, 5, Baldwin crescent, Camberwell, S.E.
May 26, 1876.	Simpson, Edward, 24, Grummant road, Peckham road, S.E,
Feb. 23, 1883.	Simpson, Isaac, 1, Junction road, Upper Holloway, N.
Nov. 23, 1877.	Simpson, T., Fernymere, Castlebar, Ealing, W.
Dec. 28, 1866.	Slade, J., F.G.S., Chappel road, Bexley heath, Kent.
Oct. 23, 1868.	Smart, William, 27, Aldgate, E.
May 25, 1866.	Smith, Alpheus (*Hon. Librarian*), 8, Hanover park, Peckham, S.E.
Dec. 28, 1888.	Smith, A. H., Lindum house, Boston, Lincolnshire.
April 23, 1880.	Smith, A. S., Silvermere, Cobham, Surrey.
Mar. 25, 1870.	Smith, F. L., 3, Grecian cottages, Crown hill, Norwood, S.E.

Date of Election.	
June 27, 1873.	Smith, G. J., F.R.M.S., 73, Farringdon street, E.C.
Oct. 26, 1877.	Smith, Samuel, Maldon house, 17, Sydenham park, S.E.
April 22, 1887.	Smith, T. F., 12, Campdale road, Tufnell, park, N.
Aug. 23, 1872.	Smith, W. S., 30, Loraine road, Holloway, N.
Aug. 22, 1884.	Smithson, T. S., Facit, Rochdale.
Nov. 28, 1884.	Snell, F. A., The Chestnuts, Chislehurst.
Sept. 22, 1865.	Southwell, C., Surrey Lodge, Child's hill, N.W.
May 22, 1874.	Spencer, James, F.R.M.S., 121, Lewisham road, Lewisham.
Sept. 25, 1885.	Spriggs, A., Bank of England, E.C.
Mar. 27, 1885.	Squire, P. W., F.L.S., F.C.S., 40, Avenue road, Regent's park, N.W.
Feb. 27, 1885.	Stephenson, J. W., F.R.A.S., F.R.M.S., 186, Clapham road, S.W.
Nov. 27, 1885.	Stevenson, G. T., Cunningham place, St. John's Wood, N.W.
Aug. 24, 1866.	Steward, J. H., F.R.M.S., 406, Strand, W.C.
June 22, 1877.	STEWART, CHARLES, M.R.C.S., F.L.S., F.R.M.S., &c. (*Vice-President*), Royal College Surgeons, Lincoln's Inn Fields, W.C.
Jan. 25, 1889.	Stocks, H., 2, Park road villas, Park road, Norbiton.
May 23, 1879.	Stocken, James, 21, Endsleigh gardens, N.W.
June 24, 1881.	Stokes, A. W., F.C.S., Laboratory, Vestry hall, Paddington, W.
May 23, 1879.	Stubbins, John, F.G.S., F.R.M.S., Inglebank, Headingley, Leeds.
Sept. 23, 1881.	Sturt, Gerald, F.R.M.S., St. Helen's, Waldegrove park, Strawberry hill.
July 7, 1865.	Suffolk, W. T., F.R.M.S., Petersfield, St. Julian's farm road, West Norwood, S.E.
June 24, 1870.	Swain, Ernest, 17, Tadmor street, Shepherd's bush, W.
Nov. 24, 1866.	Swansborough, E., 20, John street, Bedford row W.C.
Feb. 26, 1886.	Swanson, A. J., 112, Cheapside, E.C.
Dec. 17, 1875.	Swift, M. J., 81, Tottenham court road, W.C.
Jan. 23, 1880.	Symons, W. H., F.C.S., F.R.M.S., 130, Fellowes road, South Hampstead, N.W.

Date of Election.	
Feb. 25, 1887.	Tait, A. F., 77, Queen's street, E.C.
July 27, 1877.	Tanqueray, A. C., Reid's Brewery, Theobald's road, E.C.
Nov. 28, 1879.	Tasker, J. G., 30, Junction road, Upper Holloway, N.
May 22, 1868.	Tatem, J. G., Russell street, Reading.
Feb. 24, 1888.	Taylor, W. W., "The Buttercups," Sutton, Surrey.
Aug. 23, 1878.	Teasdale, Washington, F.R.M.S., Rosehurst, Headingley, Leeds.
Feb. 24, 1888.	Tebbs, H. V., F.R.M.S., 1, St. John's gardens, Notting hill, W.
Feb. 24, 1888.	Telfer, J. J., Aldborough Lodge, Amhurst park, Stamford hill, N.
Dec. 22, 1865.	Terry, John, F.R.M.S., 8, Hopton road, Coventry park, Streatham, S.W.
Feb. 24, 1871.	Thornthwaite, W. H., 14, Highbury hill, N.
June 27, 1884.	Tress, S. C., West lodge, Clapham park, S.W.
July 24, 1868.	Tulk, John A., M.D., F.R.M.S., Cowley house, Chertsey.
July 26, 1867.	Turnbull, J., Laurel house, North hill, Highgate, N.
Feb. 25, 1881.	Tyler, Charles, F.L.S., F.G.S., F.R.M.S., Elberton, New West end, Finchley road, Hampstead, N.W.
Feb. 27, 1885.	Upton, C.
Feb. 28, 1879.	Venables, W., 96, Shirland road, St. Peter's park, Harrow road, W.
Feb. 27, 1880.	Vereker, the Hon. J. G. P., Hamsterley hall, Lintz green, Newcastle-on-Tyne.
May 23, 1879.	Vezey, J. J., F.R.M.S., 55, Lewisham High road, S.E.
June 25, 1880.	Waddington, H. J., Moreton lodge, Bethune road, Stamford hill, N.
Mar. 27, 1885.	Wainwright, C. J., Elmhurst, East Finchley, N.
July 25, 1873.	Walker, J. S., Warwick road, Upper Clapton, E.
May 22, 1868.	Waller, J. G., F.S.A., 68, Bolsover street, Portland road, W.

Date of Election.	
Nov. 22, 1867.	Ward, F. H., M.R.C.S., F.R.M.S., Springfield house, near Tooting, S.W.
Feb. 25, 1881.	Ward, J. D., Northwood lodge, Cowes, Isle of Wight.
June 28, 1878.	Ward, R. J., Silver street, Lincoln.
Oct. 27, 1865.	Watkins, C. A., Rosemount, Greenhill road, Hampstead road, N.W.
Sept. 28, 1877.	Watson, T. P., F.R.M.S., 313, High Holborn, W.C.
Sept. 26, 1884.	Watson, W., 313, High Holborn, W.C.
May 23, 1879.	Watts, The Rev. G. E., M.A., F.R.M.S., Kensworth vicarage, Dunstable, Beds.
July 24, 1874.	Webb, C. E., Wildwood lodge, North end, Hampstead, N.W.
May 24, 1867.	Weeks, A. W. G., 36, Gunter grove, West Brompton, S.W.
May 23, 1884.	West, C., F.R.M.S., 7, Park row, Blackheath, S.E.
May 26, 1882.	Western, G., F.R.M.S., 2, Lime villas, West Hill road, Wandsworth, S.W.
Oct. 28, 1887.	Westerton, W. C., 4, Denmark terrace, High road, Chiswick.
Feb. 25, 1876.	Wheeler, George, 9, Cloudsley square, Barnsbury, N.
May 23, 1879.	Wheldon, John, F.R.M.S., 58, Great Queen street, Lincoln's Inn Fields, W.C.
Feb. 26, 1886.	White, R., 43, Devonshire street, Islington, N.
May 22, 1868.	White, T. Charters, M.R.C.S., L.D.S., F.L.S., F.R.M.S. (*Past President*), 32, Belgrave road, S.W.
Dec. 28, 1888.	Whitehead, C., F.L.S., &c., Barming House, Maidstone, Kent.
Aug. 22, 1879.	Whittell, H. T., M.D., F.R.M.S., Board of Health, Adelaide, South Australia.
June 25, 1880.	Wicks, W. D., 32, Burlington gardens, Acton, W.
Mar. 25, 1881.	Wildy, Arthur, 48, Albion road, South Hampstead, N.W.
April 23, 1880.	Williams, Arthur, 48, Osnaburg street, Regent's park, N.W.

Date of Election.	
Mar. 24, 1871.	Williams, George, F.R.M.S., 135, Coningham road, Shepherd's bush, W.
Nov. 23, 1877.	Williams, G. S., 20, Oxford road, Kilburn, N.W.
May 22, 1885.	Williams, T., 31, High street, Kensington, W.
June 27, 1879.	Willson, James, 65, Gloucester crescent, N.W.
Feb. 22, 1867.	Wilson, Frank, 110, Long acre, W.C.
June 24, 1887.	Wilson, W. T., Coleshill house, Berkhampstead.
April 23, 1880.	Winney, H. J., 1, Shorter's court, Throgmorton street, E.C.
Jan. 28, 1876.	Woollett, John, 58, Cloudesley road, Islington, N.
Oct. 25, 1867.	Worthington, Richard, Champion park, Denmark hill, S.E.
June 27, 1873.	Wrey, G. E. B., Addington house, Addington road, Reading.
Aug. 22, 1879.	Wright, B. M., The Museum, 26, Saville row, W.
Jan. 25, 1878.	Yates, Robert, 64, Park street, Southwark, S.E.
Nov. 23, 1888.	Young, G. W., 34, Glenthorn road, Hammersmith, W.
June 22, 1883.	Young, William Martin, 16, Maclise road, West Kensington park, W.

NOTICE.

Members are requested to give early information to one of the Hon. Secretaries of any change of residence, so as to prevent miscarriage of Journals and Circulars.

RULES.

I.—That the Quekett Microscopical Club hold its Meetings at University College, Gower Street, on the fourth Friday Evening in every month, except July and August, at Eight o'clock precisely, or at such other time or place as the Committee may appoint.

II.—That the business of the Club be conducted by a Committee, consisting of a President, four Vice-Presidents, an Honorary Treasurer, one or more Honorary Secretaries, an Honorary Secretary for Foreign Correspondence, an Honorary Reporter, an Honorary Librarian, an Honorary Curator, and twelve other Members—six to form a quorum. That the Presidents, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and the four senior Members of the Committee (by election) retire annually, but be eligible for re-election. That the Committee may appoint a stipendiary Assistant-Secretary, who shall be subject to its direction.

III.—That at the ordinary Meeting in January nominations be made of Candidates to fill the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and vacancies on the Committee. That the President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator be nominated by the Committee. That the nominations for Members of Committee be made by the Members on resolutions duly moved and seconded, no Member being entitled to propose more than one Candidate. That a list of all nominations made as above be printed upon the ballot paper; the nominations for vacancies upon the Committee being arranged in such order as shall be determined by lot, as drawn by the President and Secretary. That at the Annual General Meeting in February all the above Officers be elected by ballot from the Candidates named in the lists, but any Member is at liberty to substitute on his ballot paper any other name or names in lieu of those nominated for the offices of President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, and Curator.

IV.—That in the absence of the President and Vice-Presidents the Members present at any ordinary Meeting of the Club elect a Chairman for that evening.

V.—That every Candidate for Membership be proposed by two or more Members, who shall sign a certificate (see Appendix) in recommendation of him—one of the proposers from personal knowledge. The certificate shall be read from the chair, and the Candidate therein recommended balloted for at the following Meeting. Three black balls to exclude.

VI.—That the Club include not more than twenty Honorary Members, elected by the Members by ballot upon the recommendation of the Committee.

VII.—That the Annual Subscription be Ten Shillings, payable in advance on the 1st of January, but that any Member elected in November or December be exempt from subscription until the following January. That any Member desirous of compounding for his future subscription may do so at any time by payment of the sum of Ten Pounds; all such sums to be duly invested in such manner as the Committee shall think fit. That no person be entitled to the full privileges of the Club until his subscription shall have been paid; and that any Member omitting to pay his subscription six months after the same shall have become due (two applications in writing having been made by the Treasurer) shall cease to be a Member of the Club.

VIII.—That the accounts of the Club be audited by two Members, to be appointed at the ordinary Meeting in January.

IX.—That the Annual General Meeting be held on the fourth Friday in February, at which the Report of the Committee on the affairs of the Club, and the Balance Sheet, duly signed by the Auditors, shall be read. Printed lists of Members nominated for election as President, Vice-Presidents, Treasurer, Secretaries, Reporter, Librarian, Curator, and Members of the Committee having been distributed, and the Chairman having appointed two or more Members to act as Scrutineers, the Meeting shall then proceed to ballot. If from any cause these elections, or any of them, do not take place at this Meeting, they shall be made at the next ordinary Meeting of the Club.

X.—That at the ordinary Meetings the following business be transacted:—The minutes of the last Meeting shall be read and confirmed; donations to the Club since the last Meeting announced and exhibited; ballots for new Members taken; papers read and discussed; and certificates for new Members read; after which the Meeting shall resolve itself into a Conversazione.

XI.—That any Member may introduce a Visitor at any ordinary Meeting, who shall enter his name with that of the Member by whom he is introduced in a book to be kept for the purpose.

XII.—That no alteration be made in these Rules, except at an Annual General Meeting, or a special General Meeting called for that purpose; and that notice in writing of any proposed alteration be given to the Committee, and read at the ordinary Meeting at least a month previous to the Annual or Special Meeting at which the subject of such alteration is to be considered.

APPENDIX.

Form of Proposal for Membership.

Quekett Microscopical Club.

Mr.

of

being desirous of becoming a Member of this Club, we beg to recommend him for election.

(On my personal knowledge.)

This Certificate was read 18

The Ballot will take place 18

MEETINGS

OF THE

QUEKETT MICROSCOPICAL CLUB,

At University College, Gower Street, W.C.,

ON THE

SECOND AND FOURTH FRIDAYS OF EVERY MONTH.

1889.—Friday,	January	... ...	11	... 25
,,	February	... ...	8	... 22*
,,	March	... ...	8	... 22
,,	April	... ...	12	... 26
,,	May ...	... ...	10	... 24
,,	June...	... ...	14	... 28
,,	July...	... ...	12	... 26
,,	August	... ...	9	... 23
,,	September	... ...	13	... 27
,,	October	... ...	11	... 25
,,	November	... ...	8	... 22
,,	December	... ...	13	... 27
1890. ,,	January	... ...	10	... 24
,,	February	... ...	14	... 28*

The Meetings on the *second* Friday of each month, and on July 26th and August 23rd, are for conversation and exhibition of objects, from 7 to 9.30 p.m.

* The Annual General Meeting will be held on the fourth Friday in February, at 8 o'clock, for Election of Officers and other Business.

EXCURSIONS, 1889.

March 30.	ROYAL BOTANIC GARDENS, REGENT'S PARK. To meet at the Entrance at 3 p.m.
April 13.	CHINGFORD. To meet at Liverpool Street Station.
May 4.	WOODSIDE PARK, for TOTTERIDGE. Returning from Mill Hill. To meet at Broad Street Station.
May 18.	HARROW for STANMORE. Returning from Edgeware. To meet at Broad Street Station.
June 1.	RYE HOUSE. To meet at Liverpool Street Station.
June 15.	STAINES. To meet at Waterloo, North Station.
June 29.	WOKING. To meet at Waterloo, Main Line Station.
July 13.	OXSHOTT for ESHER COMMON. Returning from Esher. To meet at Waterloo, South Station.
July 27.	NORBITON for RICHMOND PARK. Returning from Richmond. To meet at Waterloo, South Station.
Sept. 7.	DAY EXCURSION, WHITSTABLE. To meet at Holborn Viaduct Station at 9.40 a.m. (Unless at least fifteen members notify their intention of going on this Excursion a reduction of fares cannot be obtained, and notice must be given to the Secretary of the Excursions Sub-Committee on or before August 31.)
Sept. 21.	HAYES for KESTON. To meet at Cannon Street Station.
Oct. 5.	WOOD STREET for EPPING FOREST. To meet at Liverpool Street Station.

The time for departure from town, unless otherwise specified, will be THE FIRST TRAIN AFTER TWO O'CLOCK.

Ed. Dadswell,	J. T. Powell,	Excursions Sub-Committee.
J. D. Hardy,	C. Rousselet,	
F. W. Hembry,	Jas. Spencer,	

Fredk. A. Parsons, Hon. Sec. Excursions Sub-Committee,
15, Osborne Road, Finsbury Park, N.